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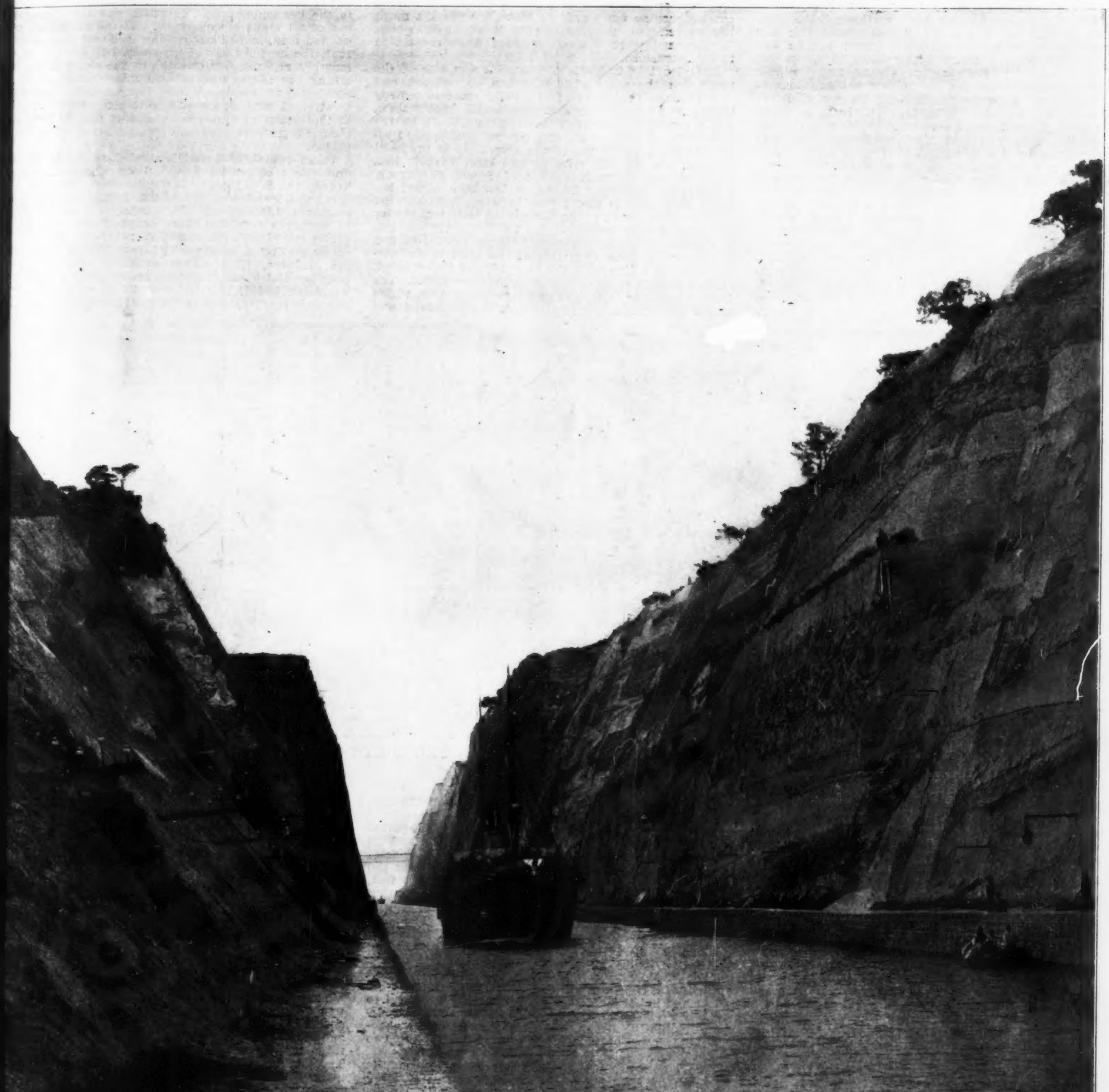


THE CORINTHIAN SHIP-CANAL.

THE CORINTHIAN CANAL.

A REPORT upon the canal which connects the Gulf of Corinth with the Gulf of Ægina, cutting its way through the Isthmus of Corinth, or Megara, may not be considered of particular value to our own country in its proposed shortening of the sea distance between New York and San Francisco, as the canal of Corinth dwindles into insignificance when compared with either the Panama or Nicaragua water routes; yet the Corinthian Canal may be considered a miniature of our projected transcontinental water route. For statistics and other data, we are indebted to Mr. A. Raugabé, general secretary of the canal company in Athens.

A few details as to the historical side of this undertaking may be of interest. In so far as the unsuccessful modern attempts are concerned, there are striking similarities between the canal of Corinth and the original Panama Canal, since both feats were undertaken and eventually abandoned by companies supported by French capital.

It was as early as 600 B. C. that Periander, tyrant of Corinth, proposed to cut his way through the little neck of land which was all that separated this city from the other centers of Greek trade; but he was confronted by too much superstition to make his scheme feasible. Both Julius Caesar and Caligula revived the canal scheme, but neither of these Romans succeeded in effecting anything. To the Emperor Nero falls the credit of the first decisive attempt to cut through the isthmus and, from evidence still to be seen, the work was prosecuted with vigor, but was interrupted by his death. The resurrection of the scheme may be credited to many in later times—to the Venetians during their occupation of the Peloponnesus, to Governor Capodistria in the early days of Greek independence, to the Cretan engineer Lygouni, and especially to the Greek government itself, which, in 1869, passed a law authorizing the construction of the canal. But it was not until 1881 that General Türr, aid-de-camp of King Victor Emanuel, obtained the necessary rights for beginning the work and organized a canal company with its seat in Paris.

The work began from the Corinthian side and was divided into five sections. Little difficulty was experienced in the first three, or about 4,700 meters (5,140 yards) of the whole. With the same dispatch, the last section jutting upon the isthmian side was made ready. It was in cutting through the 300 meters (326 yards) which stretched between these portions—a section formed of material so hard that the use of dynamite failed to dislodge a single block—that the company met its greatest drawback. Notwithstanding the extension of time accorded for the completion of the contract, the society found itself out of funds and unable to continue the work. A new subscription was made, and the society dispensed with its costly machines—which were useless in cutting through the flintlike strata—and purchased others which in the end proved as unavailable as the former ones. These and other expenses (notable among which must be recorded that of bridging the canal, at a cost of $80,000) rapidly reduced the newly subscribed capital, and in 1890 the society found itself again penniless and a receiver was appointed.

The failure of this company represented an outlay of almost $10,000,000. It was then that Mr. Syngros organized the present enterprise with a capital of 5,000,000 francs ($965,000), which rapidly, but not without hardships, completed the work. Assisted by the National Bank of Greece and the Cretan Industrial Bank, Mr. Syngros at once secured the necessary funds, and, in spite of the solid rock yet to be cut through, the canal was completed three years after the failure of the old company and the formal inauguration celebrated in July, 1893. The canal shortens the distance between all points in the Adriatic and the Piræus more than 130 miles. It is not an expensive water route, and it brings Patras and Piræus, the two centers of the export and import trade—at both of which most vessels must touch—within twelve hours of each other. Yet with all these advantages, in an age when a day's time not infrequently decides the fate of competition, the picturesque water route is almost deserted by foreign craft, and the numerous vessels which come from the north and touch at Patras persist in braving the Greek coast line, the storms off the southern capes, and the twenty-odd hours' extra sailing to a use of the Corinthian Canal.

The reason is that the canal is poorly located. The winds which render the open gulf a raging sea do not subside at the approach to the waterway. The canal is like a huge air shaft, and the mighty currents of air which rush from one gulf to the other are not calculated to encourage the mariner to run his ship between precipitous walls 260 feet high and separated by only 80 feet of sea.

A second obstacle takes the form of a reversing current, due to a striking variation in the tides of the two gulfs. The real difficulty, however, is the size of the canal itself; its width at the bottom is 68 feet 11 inches, and it has a depth of 26 feet 3 inches. The largest vessel to have used the canal was the Italian crusier "Giovanni Bausan," of the following dimensions: Length, 275 feet; beam, 42.6 feet; draft, 18.4 feet; and tonnage, 3,068. However, vessels of 23.5 feet draft and 68.5 feet beam are permitted by the regulations to pass, which dimensions would include most of the steamers regularly trading in Greek waters. Nevertheless, the exacting pilotage which such dimensions render necessary, emphasized by the reversing current, has so far served to make the canal a much less appreciated water route than it would have been in the days when steamships were more modest in their dimensions.

It is too late to think of changing the size of the route, but the other difficulties can be reduced, and it is probable that some effort will be made to remedy matters. At each approach the small breakwaters, while rendering necessary service, contribute to the difficulties of navigation, and are not sufficient to afford absolute protection to the canal. It is proposed to supersede these barriers by two large harbors that will make the approach less hazardous and will largely regulate the current. No action has been taken, but some such plan is under consideration, although the extraordinary depth of the Corinthian Gulf will render the repairs very costly.

The harbor on the Corinthian side is formed by two arms running from each side of the isthmus and terminating in a line with the two sides of the channel, so that vessels entering are ready to steer ahead. The isthmian harbor is formed of but a single arm, which closes the channel entirely toward the mainland and requires the setting of a new course, both on entering and leaving the canal.

The span of the isthmus, as traced by the canal from gulf to gulf, is 6,342 meters (3.94 miles), and its greatest depth 79.16 meters (259.7 feet). A solid block of masonry, some 6 feet in thickness, lines the base and sides of the channel to a height of 32.5 feet, or about 7 feet above the sea level, as a protection against the currents, its extremities making a substantial quay on each side from sea to sea. The sides of the channel have required no special protection of masonry, except in a few sections, notwithstanding their precipitous pitch. A passenger on one of the Greek steamers, looking up at the railroad bridge which crosses the canal at a height of 47 meters (122 feet) and is but 80 meters (262 feet) long from end to end, believes himself to be gazing almost straight upward, while the slopes of the deepest part of the channel, by reason of their greater height, rise like two perpendicular cliffs.

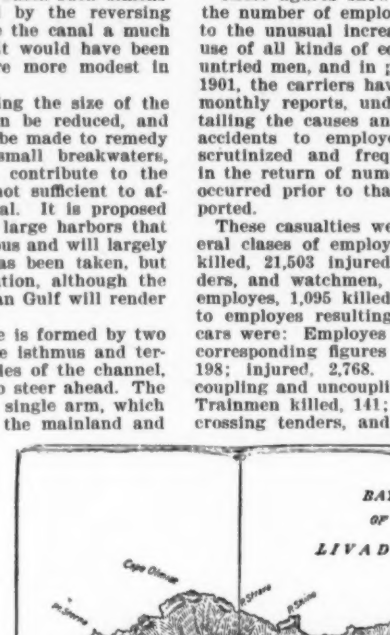
The slopes are protected from erosion by conduits which skirt the edge of the summits and carry away all surface water. Sixty electric lamps of 20 candlepower mark the channel at night, and on each side at distances of 600 feet are attached iron stanchions, to which ships may tie in case of accident or as a protection against a driving current.

If one of the present line of foreign steamers should decide that the twenty hours gained by using the canal are worth the saving at any price, or if a Greek line of steamers is fitted out to compete for a share in the far-sea trade, competition will drive the other lines in their wake, and the canal company will come into its share of the receipts which are literally going up in the smoke of every steamship which rounds Cape Matapan.

FRANK W. JACKSON.

Patras, Greece.

MAP OF GREECE, SHOWING THE COMMERCIAL SIGNIFICANCE OF THE CORINTHIAN CANAL.



THE ROUTE OF THE CORINTHIAN CANAL.

The American Standard Boiler Horse Power as adopted is: Thirty pounds of water evaporated per hour at a boiler pressure of 70 pounds, the temperature of the feedwater being 100 deg. Fahrenheit. If a boiler evaporate 300 pounds of water per hour, the boiler pressure is 70 pounds, feedwater at 100 deg. Fahrenheit, then the boiler would be 300 ÷ 30 = 10 horse power.

RAILWAY ACCIDENTS.

THE summaries of railway accidents in the report of the Interstate Commerce Commission present, in great detail, statements of accidents which are classified under the general heads of "Accidents resulting from the movement of trains, locomotives, or cars," and "Accidents arising from causes other than those resulting from the movement of trains, locomotives, or cars."

The total number of casualties to persons on account of railway accidents, as shown for the year ending June 30, 1902, was 73,250, the number of persons killed having been 8,588, and the number injured 64,662. Of railway employes, 2,969 were killed and 50,524 were injured.

These figures show a very considerable increase in the number of employes injured, a result due in part to the unusual increase in traffic and the consequent use of all kinds of equipment and the employment of untried men, and in part to the fact that since July 1, 1901, the carriers have been obliged by law to render monthly reports, under oath, to the Commission, detailing the causes and circumstances surrounding all accidents to employes, the reports being carefully scrutinized and frequently corrected, which results in the return of numerous accidents that, if they had occurred prior to that date, would not have been reported.

These casualties were distributed among three general clases of employes, as follows: Trainmen, 1,674 killed, 21,503 injured; switch tenders, crossing tenders, and watchmen, 200 killed, 1,443 injured; other employes, 1,095 killed, 27,578 injured. The casualties to employes resulting from coupling and uncoupling cars were: Employes killed, 167; injured, 2,864. The corresponding figures for the year 1901 were, killed, 198; injured, 2,768. The casualties connected with coupling and uncoupling cars are assigned as follows: Trainmen killed, 141; injured, 2,475; switch tenders, crossing tenders, and watchmen killed, 17; injured, 285; other employes killed, 9; injured, 104. The casualties due to falling from trains, locomotives, or cars in motion were, trainmen killed, 371; injured, 3,821; switch tenders, crossing tenders, and watchmen killed, 40; injured, 276; other employes killed, 80; injured, 570. The casualties due to jumping on or off trains, locomotives, or cars in motion were, trainmen killed, 78; injured, 2,681; switch tenders, crossing tenders, and watchmen killed, 12; injured, 203; other employes killed, 50; injured, 452. The casualties to the same three classes of employes from collisions and derailments were, trainmen killed, 534; injured, 3,350; switch tenders, crossing tenders, and watchmen killed, 12; injured, 70; other employes killed, 87; injured, 640.

The number of passengers killed during the year was 345 and the number injured 6,683. The corresponding figures for the previous year were 282 killed and 4,988 injured. As a result of collisions and derailments 170 passengers were killed and 3,429 injured. The total number of persons other than employes and passengers killed was 5,274; injured, 7,455. These figures include casualties to persons classed as trespassers, of whom 4,403 were killed and 4,854 were injured. The total number of casualties to persons other than employes from being struck by trains, locomotives, or cars were 4,021 killed and 3,973 injured. Casualties of this class occurred as follows: At highway crossings: passengers killed, 3; injured, 9; other persons killed, 824; injured, 1,326; at stations: passengers killed, 29; injured, 382; other persons killed, 343; injured, 482; and at other points along track: passengers killed, 7; injured, 19; other persons killed, 2,815; injured, 1,755. The summaries giving the ratio of casualties show that 1 out of every 401 employes was killed, and 1 out of every 24 employes was injured. With reference to trainmen—including in this term enginemen, firemen, conductors, and other trainmen—it is shown that 1 was killed for every 135 employed, and 1 was injured for every 10 employed. One passenger was killed for every 1,883,706 carried, and 1 injured for every 97,244 carried. Ratios based upon the number of miles traveled, however, show that 57,072,283 passenger miles were ac-

complished for each passenger killed, and 2,946,272 passenger miles accomplished for each passenger injured. The corresponding figures in these latter ratios for the year ending June 30, 1901, were 61,537,548 and 3,479,067 passenger miles for each passenger killed and each passenger injured, respectively.

AN ABYSSINIAN CITY.

THE city of Harar seen from a distance has an impressive aspect which is hardly borne out on entering within its walls. But even before you reach the gates you can see the signs of a populous town. The road for miles beforehand is covered with camels, mules, herds, and flocks, messengers and couriers, all wending their ways toward the old Galla capital. The position is well adapted for a trade center, situated as it is on the southern slopes of a range of mountains which bar the approach to the next plateau on your journey northward. The round cupola-shaped church dedicated to St. Michael and St. George and erected in commemoration of the conquest of Harar by the Abyssinians, standing on the crest of a hill overhanging the town, can be seen from afar long before you come within sight of the city itself. The roads, or rather tracks, by which the vast plain is traversed all converge toward Harar. From without little is visible except the long line of black, sunburnt stone walls by which the city is girt in every direction. There are, I was told, eleven gates to the city, and each one opens on roads leading to different provinces. The one we entered was supposed to be the principal gate, as standing close to the custom house. It is characteristic of the country that while for some dozen miles south of Harar we rode over a fairly good road provided with bridges along which a cart could have passed safely, we had before entering the city to climb for a quarter of a mile at an angle of some forty-five degrees over a mass of jagged stones, from one to another of which our heavily-laden mules skipped with an agility equal to that of goats. The gates of Harar are closed at 6 P. M., and not reopened till 5:30 A. M. During this period no one can enter or leave without the special permission of the governor. No inhabitant of the town is allowed to reside outside the wall, though there is any amount of unoccupied land on the hillsides close at hand, where the air is far fresher and healthier than inside the town, within which the houses are crammed together higgledy-piggledy. In defiance of all considerations of sanitation or comfort, however, the city is said to be very free from epidemic disease, and the climate, especially to one coming from the sultry seashores of the Indian Ocean, is absolutely delightful, its height above the sea being close upon 1,800 meters.

The partisans of the French route were confident that the railway would completely supersede the caravans. The opponents of the railway contended that a considerable portion of the Harar traffic would continue to go through British Somaliland, owing to the preference of the natives for British administration as compared with French. They argued—as it seems to me with more reason—that it would never pay the natives to export agricultural produce to the coast, even at very reduced rates, and that tobacco, hides, and ivory, and, under certain conditions, cotton, were the only articles which could afford to pay for export even at very reduced rates of transport from those existing at present. No official tariff of freights chargeable by the railway has yet been formally published. As things are, the cost of transport by camel from Harar to the railroad is about 20s. per ton. But this amount would be very materially reduced if a cart road could be constructed between the city and the terminus, an operation which might easily be carried out at a comparatively small outlay. How far there is an immediate prospect of any large development of agricultural production in the districts adjacent to the province of Harar is a moot point on which I do not feel competent to express an opinion. All I can say is that my French informants attached extreme importance to the tendency of railways to open new sources of production, while my English informants argued that there could be no material increase of agricultural production without irrigation; that there was no native capital available for purposes of irrigation, and that foreign capital was not likely to be invested in the development of Abyssinian enterprise so long as there was no possibility of purchasing lands in freehold, or on leases of any serious duration, or so long as there remained a doubt as to the maintenance of order and law in the event of the death of the reigning emperor. There is much to be said on both sides. The only contribution I can afford to the controversy from my personal observation is that under the reign of Menelek foreigners can travel unarmed throughout a very wild and desolate country, amid a semi-savage population with absolute immunity from outrage or molestation or even annoyance. This immunity from danger is, I am assured, simply due to the abject terror inspired among the natives by the dread of the consequences which would inevitably accrue to them if they incurred the displeasure of the Negus. But, after all, the maintenance of order and tranquillity is the first step toward civilization, and this boon, at any rate, Menelek has conferred upon his subjects. He has also introduced a new silver coinage, minted in France, and based upon the decimal system in lieu of the old Maria Theresa dollars.

Statistics are unknown in Abyssinia, but the population of Harar is estimated by all the foreign residents with whom I made acquaintance at between 30,000 and 40,000—nearer the latter figure than the former—and I should judge myself, from the dense crowds in the streets, this estimate was below the mark. The bazaar consists of three long, winding, narrow streets jutting off from the market place. In these streets there must be some hundreds of booths or stalls within which the native merchants, Somalis, Gallas, Arabs, Armenians, Persians, and Hindus, sit squatting cross-legged, waiting for customers. The wares displayed in these booths were, as a rule, bales of Manchester shirting, American calico, and native muslin. Besides these I saw piles of cheap cutlery, silver bangles, beads, and a collection of the heterogeneous articles which used in my time in South Africa to be known by the expressive name of "Kaffir truck." I admit that if I had been asked what I would give for the whole stock in trade of the bazaar merchants I should have been afraid to bid £20 a lot, but I have seen enough of Eastern countries to know that it is impossible to say how far the shop front is a standard by which you can safely estimate the value of the shop's contents. I can remember in the days before the British occupation the aspect of such important native Egyptian towns as Tantah, Assiut, Damanhur, and Zagazig, and I doubt whether their aspect in those days would have inspired financial confidence in the mind of any intelligent foreigner. Subsequent experience, however, has shown that as soon as order and security were established the native traders in these towns possessed far greater wealth than that with which they were previously credited; and under similar conditions the same discovery may be made in the case of Harar.

I had the opportunity of discussing the actual and potential trade of Harar with leading foreign residents who were all more or less personally interested in the subject. For obvious reasons I cannot cite their names, but I may state that I found a general consensus of opinion to the effect that there was a real permanent market in Harar for Harari tobacco, cotton, hides, mules, cattle, ivory, and doura, that considerable mercantile transactions took place daily in these articles, and that there is every reason to suppose the amount of goods exported from the Harar district will increase largely with the improved facilities of transport provided by the opening of the railway within easy reach of the town and its vicinity. The most trustworthy estimate I could obtain gave the number of tons of merchandise annually exported from Harar as 10,000 tons, this being the maximum amount of tonnage which could reasonably be counted upon from the city to the railway during the present year. The official calculation of the railway authorities was, I should add, more than twice this amount. All my informants were substantially agreed that the bulk of this traffic must eventually be carried by the railway to Jibuti, instead of, as at present, by the caravan route to Zeila or Berbera.—London Times.

THE "DISCOVERY."

INTERESTING ANTARCTIC EXPERIENCES.

THE New Zealand Shipping Company's steamship "Paparoa," which was in Lyttelton Harbor when the relief ship "Morning" arrived from the Antarctic, anchored in Plymouth Sound on Sunday. She brings home the first member of the "Discovery's" crew to reach England, and also one of the crew of the relief ship "Morning."

Reuter's representative, in conversation with passengers, learnt that the "Morning" was signaled off Lyttelton Roads at 7:15 A. M., on March 25 last, having been absent nearly four months in the Antarctic, and, although her arrival was unexpected, she met with a great reception on reaching the wharf. The mayor of Lyttelton and a number of representative officials at once boarded the relief ship and congratulated Capt. Colbeck on his return. In interviews on their arrival the "Morning's" crew said that often they found the heat of the perpetual sun oppressive and that they actually became sunburnt. It was a curious experience passing Christmas and the New Year in perpetual daylight and at midnight to play cards on deck with the sun beating down. Later on darkness began to assert itself, and midnight was marked by faint shadows like twilight. The "Morning" reported that the "Discovery," when she left that vessel, was snugly lying in a well-sheltered spot and that her men were then blasting the ice to force a passage.

Details have already been telegraphed by Reuter's Agency from New Zealand of the great southward sledge journey made by Capt. Scott, but little has been heard of the important expeditions undertaken by Lieut. Armitage, the second in command. The following are extracts of an account of this journey published the day before the "Paparoa" left:

"The expedition, headed by Lieut. Armitage and Lieut. Skelton, was of great importance. In the face of great difficulties the party scaled a glacier 9,000 feet high where, owing to the rarefied air, one man suffered severely. The party had no dogs and were, therefore, compelled to drag their own sledges. For a portion of the journey they were accompanied by Dr. Köttlitz and eight men from the ship. The work was terribly hard, as the sledges had to be continually unloaded, lowered down crevasses 50 to 60 feet deep, and hauled up on the other side. The party were roped together, but on one occasion Lieut. Armitage fell down a crevasse hundreds of feet deep. Fortunately his rope held, and he was hauled up uninjured."

Some thrilling experiences were narrated by a young New Zealander named Hare, who was one of the "Discovery's" staff. In the course of conversation he said:

"It was in March last, just a year ago, that Mr. Barne, with a party of 15 officers and men, set out from the "Discovery," then lying in her winter quarters, to deposit a record at Cape Crozier, to be left for the benefit of the relief ship, to guide her to the "Discovery." When the party left the vessel, with a full equipment of sledges and tents, she was not thoroughly frozen in, and the sea ice was not strong enough to be used as a highway. The party had therefore to climb on to the land, ascending about 900 feet, and make along the land ice instead of taking the short winter route round Cape Armitage. All went well for ten days, and at the end of that time, having descended again to the sea level, the party arrived at the foot of Mount Terror, only to find the snow too soft to allow of a further advance. In these incumbrances three of the officers volunteered to go on alone, and to them was intrusted the fulfillment of the mission, the rest of the party returning in the direction of the vessel. They were probably not more than ten miles from home when a fearful blizzard was encountered. It was a terrible ordeal, and it soon got so bad that Mr. Barne decided to abandon the tents and sledges, leaving the dogs to find their way back to the vessel as best they could.

"Leaving our belongings, we began to tramp back to the ship, but we could not see two yards in front of us, the snow was falling so thickly. It quickly piled up into huge drifts, and these made our journey very hard. Not long after we started I got separated from the rest of the party, and was lost. I can remember wandering about for a long time trying to get on the right track for home, but I could not make out where I was, and in the howling storm I became thoroughly exhausted. I must have fallen down out of sheer weariness and gone straight off to sleep in the snow. I heard afterward that on two succeeding nights they sent out search parties after me, but could not find me, and it is not to be wondered at, for I was lying asleep under the snow all the time. After the second attempt they gave me up for lost, thinking I must have succumbed to exhaustion and been buried in a snowdrift. This is just what did happen, but I was buried alive, and not dead, and somehow or other I remained alive. On the second day I woke up in the morning. The warmth of the sun soon revived me, and by the time I was fully awake I had begun to understand where I was and what had happened to me. I looked round me, and soon discovered the vessel, and I did not lose much time in starting out for her. When I arrived all on board got a great surprise and the doctor was amazed at my appearance. . . . It must have been 46 hours from the time I lost myself until I reached the ship, and I suppose I was asleep for 36 hours. I suffered no ill effects. It was a wonderful experience, but I don't want another of the same sort."

The seaman who was lost—Vince by name—was a member of this expedition, and, concerning his death, Mr. Hare said:

"Vince and three others seem to have got away by themselves and made off in the right direction. About four miles from the ship there was a long slope to be descended, and they reached what they thought was the edge of it and began the descent. They had gone about half a mile, almost blinded by snow all the time and unable to see where they were going, when Vince suddenly disappeared, apparently falling straight down only a yard or two in advance of the rest of the party. Then they discovered that they were on the edge of a huge precipice, over which Vince had fallen, the others narrowly escaping the same fate.

"As soon as the three men reached the ship they reported the accident, and, the gale having moderated, search parties were at once sent out. They could find no trace of the missing man, and on the following day they were still unsuccessful. No other conclusion could be come to than that Vince had been drowned."

In the course of a letter written by Mr. Bernacchi, dealing with some of the magnetic work, the writer says:

"One of the most typical of the magnetograms for the year 1902-3, with data for reduction, has been sent home in case something should happen to us before the return of the expedition. The seismograph has been working the whole year, but very few shocks and tremors are recorded. Our largest are on May 25 and on September 22, which seems to correspond with your record on April 18. There are some irregularities in the line which might be due to the Guatemalan earthquake. There are some tremors, however, which coincide with your record. From October 3 to October 8 a great many tremors were recorded. I also have a year's observations of atmospheric electricity."

Regarding the voyage of the relief ship, Capt. Colbeck reported that on Christmas Day last, three weeks after sailing from Lyttelton, he crossed the Antarctic circle. On that day two islands were discovered. On January 3 Victoria Land was sighted, and a blizzard sprang up that lasted for six days. On January 8 a landing was effected at Cape Adare, a precipitous basaltic rock 3,700 feet high. Proceeding through heavily packed loose ice, a party landed at Possession Island, which was covered with penguins. Those on the "Morning" stated that the birds had made a wide track to the center of the island, having removed the larger stones from the paths, which by long usage had become quite smooth. The south of Possession Island was closely packed with ice, which in the neighborhood of Wood Bay and Coulman Island was especially heavy. On January 14 a landing party left a record at Franklin Island, and four days later letters from Capt. Scott which had been deposited at Cape Crozier were taken off. Three days after this the "Morning," having forced her way through the ice pack, sighted the "Discovery," which was separated from the relief ship by no less than ten miles of fast ice, and on the following day, by means of sledges, the two Antarctic expeditions met. By February 26, as some of the ice had broken away, the distance separating the two ships was reduced to five miles, but not even the heaviest gales had the effect of further breaking up the intervening icefields. The "Morning" bade adieu to the "Discovery" on March 2, when she steamed out of the ice on her return to New Zealand, having transferred to Capt. Scott's vessel in circumstances of great difficulty the stores, clothing, and coal for the "Discovery." Had she remained longer, she, like the "Discovery," would have become shut in.—London Times.

Floor Wax—

1.

Potash	32 parts
Water	314 parts
Yellow wax	32 parts
Annatto	8 parts

Dissolve the potash in the water, heat to boiling and add the wax, and finally the annatto to color.

2.

Yellow wax	1 part
Kerosene	8 parts

Dissolve the wax in the kerosene over a hot plate (not over open fire). The mixture while hot is spread on the floor in a thin layer. A thin layer of wax remains after the kerosene evaporates and this is rubbed lightly with a cloth, until the desired polish is obtained.—Pharm. Era.

HERTZIAN WAVE TELEGRAPHY.

DR. FLEMING'S FOURTH PAPER.

The lecturer said that he proposed to discuss the question of long-distance wireless telegraphy in view of the problem of privacy, which was a necessary part of every telegraphic system. This was a matter which had occupied public attention to a great extent, and about which there were many conflicting opinions. It was difficult to deal with it fully, because not only were there scientific principles involved, but there were also business interests to consider, which prevented full explanation on all points. The commercial considerations which had to be thought of did not allow the subject to be discussed on the simple ground of the advancement of knowledge; but, still, he was able to discuss the scientific principles involved in the matter. He would first deal with the isolation of the stations, and consider whether it was a fact that all the receivers within range were affected by Hertzian waves. It would be best to obtain clear conceptions of the subject by beginning with definitions. The first condition desirable in a station was that it should be able to avoid the reception of signals when it desired, and the second that it should not be overheard when it was desired that its message should be secret. The first condition might be defined as isolation, and the second as the prevention of overhearing. If a station could pick up all that it wanted, that was one thing; and if it could keep secret any such signals as it desired, that was another. It must be remembered that any telegraph or telephone wire could be tapped by a person who had sufficient skill and the time to give to the subject; but there were penalties against such proceedings, and the result could only be obtained by considerable trouble. At present there were no penalties for receiving waves through the ether.

The first thing was to prevent a given receiver being affected by other waves than those which were intended for it. This was effected by a system called syntony, or tuning, and was based on the adjustment of the capacity and inductance of aerials, so that they only responded to waves of a given time period. Two years ago, in his lectures on this subject before the Society of Arts (see Engineering, vol. lxx., pages 705, 741, 772, and 804), he had explained what was the natural time period of a circuit, and had shown that to obtain the best results, impulses, or etheric waves, must come at a definite rate. This rate depended upon the speed at which the impulses ran backward and forward across the spark-gap in connection with the induction coil. The lecturer here threw upon the screen the photograph of a spark which had been taken on a rapidly-moving photographic band, which ran at the rate of 150 feet per second. The sparks were shown as luminous zones divided from each other by dark bands, and from the measurement of the spaces it was deduced that the frequency of the spark was 14,000 per second. The formulæ for calculating the periodic time of electric oscillations were given in our report of the second lecture. Ordinarily the waves are divided by intervals of quietude, as shown in Fig. 1, *ante*, the undulating line representing the discharge between the spark-balls, and the straight line the time during which the capacity was being recharged. Trains of waves followed each other like the trains of a railway, the interval between them being relatively very great. Fig. 2 showed two distinct characters of waves. In the upper line the circuit was strongly damped, and the waves tended to die away very rapidly; while in the lower diagram the circuit was feebly damped, and the waves persisted for a very considerable time.

The lecturer here performed an experiment to show that one circuit traversed by an oscillating current can set up oscillations in the second circuit, as shown in Fig. 3, where on the left-hand side is a transformer, with a capacity and a spark-gap, sending an oscillating current round a coil wound on a frame; and on the right-hand side is a second coil, in which currents are induced which show themselves in a small electric lamp included in the circuit. The lecturer explained that it was only when these two circuits were in tune with one another that the second would show a light, and that if the inductance or resistance were altered in either of them, the effect would be to destroy the syntonism between them. He had an adjustable coil by which the inductance could be altered, and he was able to show that a slight alteration put one coil out of tune with the other. The apparatus shown in Fig. 3 does not depend upon Hertzian waves, but upon electro-magnetic induction; but in that in Fig. 4, which is due to Siebt, true Hertzian waves were rendered visible to the audience. On the left-hand side is a coil with a spark-gap; on the right-hand side are two spiral wires, each ending at the top in a vacuum coil, which could be made to glow when oscillations were induced in the wire below. The coil for this spark-gap produced Hertzian oscillations in a large sheet of zinc laid on the table, while the two coils to the right were absolutely free from any electric connection with the zinc; they were insulated on stands. It was possible to tune the left-hand circuit in such a way that the left-hand vacuum tube lighted up when the coil was at work, the right-hand tube remaining dark. Then, by altering the inductance in connection with the coil, the right-hand tube would light up, and the left-hand tube would remain dark. Thus, the lecturer showed to the audience that it was only when the second circuit was in syntonism with the first that any appreciable current was produced. It was upon this system that Mr. Marconi tuned his receivers.

Dr. Fleming continued by saying that Marconi's tuned aerial required for its proper working that the time period of the circuit of the transmitter and its aerial should be the same as the time period of the circuit of the receiver and its aerial. This, he said, was well understood, but there arose a question of great importance as to whether this tuning was, of itself, sufficient to prevent confusion between incoming messages. As a lecture-room experiment it had answered perfectly well, but many people had expressed a doubt whether it would be equally satisfactory when tried on a large scale. Marconi had demonstrated it in 1900, between the Isle of Wight and Poole, a fact which he (the lecturer) had borne witness to in a letter to the Times, on October 4, 1900. Since the erection of the large station at Poldhu, in which the electricity was generated by engines of considerable size, it had been publicly asserted that syntony provided no guarantee as to the discrimination of signals. It was thought that the enormous and powerful waves sent out from the large power-station would play havoc with all those smaller waves from apparatus of less size. If true, this was a very serious criticism, and he felt that it was incumbent on him to lay clear evidence before his audience on this point, and not try to evade the question. Mr. Marconi had stated definitely that the waves sent out from his power-station would not have any influence upon those sent out from ships in the Channel, while his critics had asserted the contrary very strongly. Upon this point he knew that his audience wanted facts, and he had been at considerable pains to obtain them for them. It was a vital matter that the communication which had been established between ships and shore should not be disturbed. Mr. Marconi had earned the gratitude of humanity by what he had done in this respect, and he had offered him (the speaker) opportunities for verifying all his claims. As far as he was concerned, the experiments of 1900 were conclusive, because he had been associated with the system for a long time, and, from his experience of it, was not inclined to be skeptical. But as his audience were probably not in that frame of mind, he had asked Mr. Marconi to give him absolute control over a set of experiments, in order that he might bring before them absolute proof as to the contention that the signals from the power station, and those from small apparatus on board ship, could be sent and received side by side without creating any confusion.

Dr. Fleming here threw upon the screen the map shown in Fig. 5, in which the position of Poldhu, the Lizard, and Poole were clearly shown. He had been last week to Poldhu, accompanied by confidential assistants, and had been given perfect control over the whole apparatus during the time of his experiments. At Poldhu there was the great aerial used for transmitting messages across the Atlantic, and within 100 yards of it there was a single mast of the small type, which was used for communicating with ships at sea. At the Lizard there were two receivers joined to one aerial; one receiver being tuned to receive waves from the power station at Poldhu, and the other to receive waves from the ship station at Poldhu. Further, at Poole, there was a receiver which was set to work in harmony with the power station at Poldhu. He went down to Cornwall provided with sixteen telegraphic messages, enclosed in sealed envelopes, and each marked with the hour at which it was to be sent off. Eight of these were for the ship-signaling, and eight for the power-signaling. They were confided to an assistant at Poldhu, who was not to let them out of his possession until the time marked upon them. At two o'clock, say, he handed in one message at the power-station, and one at the ship-station, and ordered them to be sent continuously for ten minutes, the messages being sent time after time through the whole of that period. At the Lizard these messages were written down simultaneously by the Morse instruments; and at Poole, which was out of range with the ship station, the power message was taken down, transcribed, and sent on the Post Office telegraph, to be re-transmitted over the wires back to the Lizard. At 2:15 a second pair of messages were handed in, and so on every quarter of an hour, until the whole eight pairs had been sent. Dr. Fleming had on the table his original messages, the tapes on which they were received, their transcription into writing, and the messages received over the Post Office wires, stamped with the times at which they were received at the Marconi station, and in all cases the message received was an exact copy of that which was transmitted, and which, until the envelope was opened, was known to no one but Dr. Fleming. The power station was working at the full power of 28 horse power, while the ship station was working at one-tenth horse power. The former sent out waves which might be likened to a bellow, while the latter merely sent out whispers, and yet the tuned receivers each picked out their own particular messages and paid no heed to the others. Four of the messages sent were in difficult cypher, and one of them proved to be somewhat blurred, but it was afterward found that this was due to the s.s. "Philadelphia," which was passing down the Channel and telegraphing at the same time. Dr. Fleming thought his hearers would consider this test was an absolute proof of the fact that the syntonized instruments were able to pick out their own messages; in fact, common sense would suggest that Mr. Marconi would never destroy his busi-

Fig. 1.

Trains of Damped Oscillations or Electric Waves $y = e^{qt} \sin pt$.

Fig. 2.

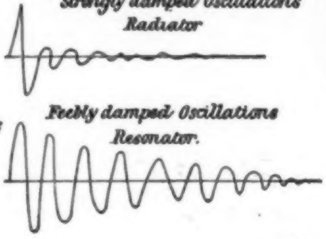
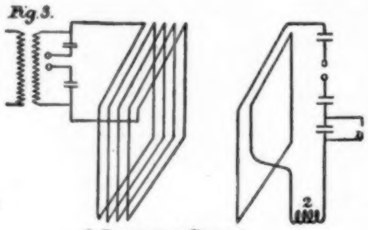
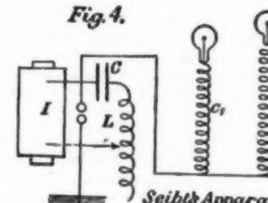


Fig. 3.



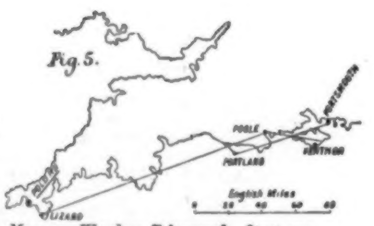
Co-Resonant Circuits

Fig. 4.



Seibt's Apparatus for showing Resonance of Coils.

Fig. 5.



Marconi Wireless Telegraph Stations.

Fig. 6.

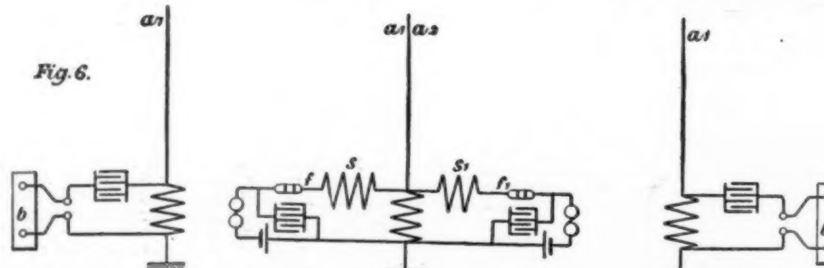
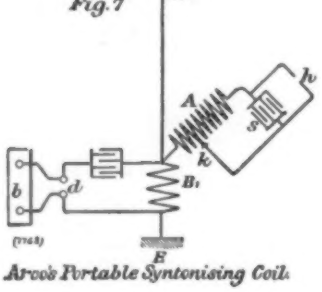


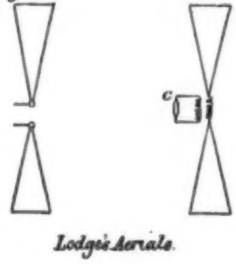
Diagram of Slaby's Multiple Telegraphy Connections (1900.)

Fig. 7



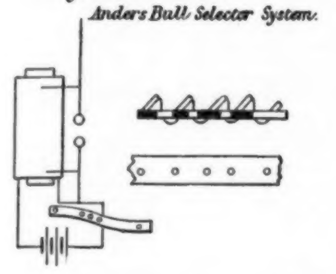
Arco's Portable Syntonising Coil.

Fig. 8.



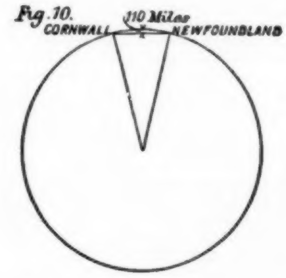
Lodge's Aerials.

Fig. 9.



Anders Bull Selector System.

Fig. 10.



ness with the ships—twenty-five of which were now fitted with his apparatus—in order to run his transatlantic messages.

Dr. Fleming said that electric circuits were of two kinds—namely, stiff and responsive. As an analogue, he had a vertical flat spring fixed at its base, with a weight attached at the top; this spring was very elastic, and a single touch put it into vibration. This was an example of a responsive circuit. As an example of a stiff one, he recounted how at Poldhu, when they were about to build the large mast, he saw a balk of timber, 50 feet long, lying on two supports. He found that he could walk upon it with scarcely any deflection, but by pressing it with his hands, with impulses timed to the period of the balk, he was able to get it into oscillation, with a deflection of 1 inch to 2 inches, and if he could have continued his pressures sufficiently long, and with perfect regularity, he was certain that he might have broken the balk in two. This was an example of a stiff circuit, and it showed that such a circuit could not be started into oscillation by a mere flip, but must have a steady series of impulses timed exactly to suit its period. As another example to aid his audience in grasping this point, he adduced a cork floating in water; every little billow and ripple lifted it from its position, while a big heavy body—like a balk or the Liverpool landing stage—could only be put into motion by a continuous succession of waves timed to the right period. The transmitter which was operated from the power station at Poldhu, with its 28 horse power, was one of these stiff circuits, and could only be set in operation by a regular series of successive impulses.

Turning to the other systems of syntonic telegraphy, Dr. Fleming referred to that of Slaby, illustrated in Fig. 13, *ante*. In this, as described in the last lecture, a horizontal wire is led away from the base of the aerial, and has a coherer with a receiving instrument at its extremity. When the apparatus has been tuned, both to the fundamental note of the aerial and also to the first harmonic, the arrangement is like that shown in Fig. 12, *ante*, in which there are two wires led from the base of the aerial, one three times the length of the other; and there is a coherer, or kumascope, at the end of each wire, one responding to waves four times the length of the aerial, and other to waves of the same length as the aerial. The arrangement of the apparatus in Slaby's multiple telegraphic connections is shown in Fig. 6, wherein two transmitting aerials are shown, one at either side of the figure, with a receiver in the middle, capable of responding to either of the other two.

In order to simplify the tuning of circuits, Count Arco had devised an apparatus, shown in Fig. 7, which comprised a portable syntonizing coil. The coil *A* was connected at one of its ends with the lower end of the aerial a_1, the other end of the coil was coupled to one pole of an experimental spark circuit *H*, the other pole being fitted with a movable contact *K*, made to slide in such a way on the coil *A* that it could be set on any of the coil turns. The condenser *s*, the capacity of which was equal to the coherer used, was in parallel with the experimental sparking circuit. If the spark circuit of the transmitter was started, the tension effects were shown simultaneously at *L*, where sparking became faster; but ultimately the oscillations of the coil *A* corresponded with those of the transmitter and those of the aerial. The coil *A* would, under the best conditions, be in harmony with the transmitter when the sparks at *H* had reached their greatest length. By noting the position of the contact *K*, the period of the transmitting circuit could be fixed, and then by moving the syntonizing coil to another circuit, this latter could be adjusted to bring it into tune with the original circuit to which the syntonizing coil was first applied.

Fig. 8, said the lecturer, represented Lodge's aerials, which are broad plates of the form shown. These would create a very responsive circuit, which, he thought, would be very difficult to tune; they would respond very easily to vagrant waves. Of course, he did not mean to suggest that it was possible to send messages which no one could steal, provided they brought sufficient time and skill to the task; he did not think that such a result could be attained.

Another syntonic system was Braun's, which is illustrated in Fig. 14, *ante*. In this the aerial wires were arranged horizontally, and Dr. Fleming doubted whether it would be possible, by this disposition, to signal over great distances.

M. Blondel had made a very ingenious suggestion, that the discriminating feature of sets of waves should not be the time period between the waves themselves, but the interval between the groups of waves, and that these intervals should be detected by the aid of the telephone.

A very ingenious system for communication between warships, in which the most absolute secrecy was necessary, had been devised by Mr. Anders Bull, and is illustrated in Fig. 9. In this the sending is effected by means of a punched tape, in which some orderly arrangement of holes represents the dot, and two such arrangements of holes, making two dots, represent the dash. These dots are reproduced by the receiver, and are afterward translated into the corresponding Morse signals by the aid of the apparatus, which is shown diagrammatically to the right of the sketch, in which there are five contact-pieces which pass through the holes in the punched tape, and, by means of other apparatus, give the message in dots and dashes. It is possible to intercalate the signals sent in such a way that they come to the receiver as a "mess of waves;" and it is only those who possess the key—named the "discriminator"—who are able to sort them out into an intelligible message.

Dr. Fleming said that he would now turn to the question of long-distance wireless telegraphy. Much of the apparatus that was used was of a secret nature, and he could not divulge its construction. A vast amount of work had been done in translating the early appliances into engineering devices to be used with the power system. One of the questions which had been debated was, What effect the curvature of the earth would have on the waves, as shown in Fig. 10? The versed sine of the arc between Cornwall and Newfoundland was 110 miles; that was to say, a mountain 110 miles high interposed between the two places, and the signals had to go around it. In the case of signaling to Cape Cod the height was 300 miles. They had been unable to predict exactly what would be the effect of the rotundity of the earth, but they assumed that when transmitting to great distances the impulses would follow the law of inverse squares, and they had added something on for contingencies. Since the work had been commenced, McDonald has investigated the subject of electrical waves mathematically, and had thrown much light on the question. The passage of a wave round the corner depended on the length of the wave and the size of the object. If he placed his hand before his mouth, it made very little difference to his audience, for the waves emitted were 4 feet to 6 feet long; but if he placed an orange in front of a whistle, the effect was very marked, as in that case the waves were very much smaller. At Poldhu they were using waves of the length of one-fifth of a mile, so that 10,000 wave-lengths would reach across the Atlantic. On the other hand, waves of yellow light were only 1-50,000 inch in length, and bore the same relation to a pea that the Poldhu waves did to the earth. Supposing that two instruments were placed in syntony with each other at a distance of 3,000 miles on a flat plane, and then they were removed to the earth, it would be found that one would not respond to the other, and that the vibrations must be increased more than three times to gain the effect. At 7,000 miles a far greater increase would be necessary, and the longer the distance the longer must be the wave-length. As to whether it would ever be possible to telegraph, by using waves, to New Zealand, he would not predict; but it was absolutely certain that waves could not be sent all around the world. The attempt to do so would be like trying to send a whisper to one's own ear all round Westminster Abbey. It was conceivable, however, that Hertzian waves might be sent to the opposite side of the globe. When Mr. Marconi lately went to America he found that it was more easy to pick up the signals by night than by day. In the daytime the limiting distance was 700 miles, and at night it was 2,000 miles. He had suggested that possibly the daylight might have some effect upon the waves. J. J. Thomson, at Cambridge, had shown the electrons were capable of absorbing long etheric waves, and if electrons were being shot out from the sun, it would follow that the side of the earth which was luminous would be less transparent to Hertzian waves than that which was in darkness. Upon this hypothesis there would be an electric fog, or electric haze, which would render it difficult for the waves to get through.

Dr. Fleming said that there were many unsolved problems in connection with this subject. We had still to learn how to localize the source of the waves. Our kumascopes were like the rudimentary eyes of some animals which served to tell the difference between light and dark, but yet did not give them vision; it was necessary to improve the electrical eye of the apparatus in order to localize the source of the radiation. A step in advance had recently been made by the magnetic kumascopes, which were more sensitive than the coherer, and, perhaps, would eventually enable them to decide from what direction the waves were coming. There was also room for improvement in the matter of manufacturing oscillations. At present they did not confine themselves to the long waves which they utilized. A spark-gap threw off short waves, which absorbed 95 per cent of the energy of the generator; and at Poldhu, where the power was 30 or 40 horse power, this spark-gap gave a powerful illumination, which was very dangerous to the eyes. The solution of the problems yet to be solved called for real scientific ability, and also for high engineering skill. The subject was of the greatest importance, and well worthy of the effort that was being put into it. It promised a splendid reward for those who succeeded in this matter—"in controlling the powers of Nature for the use and convenience of man."

Removal of Peru Balsam Stains.—The stains of Peru balsam may be removed from textile fabrics by the aid of chloroform. The fabric is spread out, a piece of filter paper being placed beneath the stain, and the latter then copiously moistened with a small cotton pledget wet with chloroform. Rubbing is to be avoided.—Drug. Circ.

THE BATAULT ELECTRIC WATTMETER FOR SIMPLE ALTERNATING AND POLYPHASE CURRENTS.

We illustrate herewith a meter which is equally adapted for simple alternating and for polyphase currents, and which is remarkable by reason of its simplicity. It operates by Foucault currents, or currents generated in a body displacing itself in a magnetic field. Figs. 1 and 2 illustrate the type for simple alternating currents. Fig. 1 gives a general internal view of the meter, and Fig. 2 a section showing all the interior details.

The apparatus consists of a vertical spindle pivoted in sapphires, revolving an aluminium disk, and setting in motion a clockwork movement, *M*, for actuating the hands of a dial placed at the upper part of the meter. In the latter there is an electro-magnet with a U-shaped sheet iron core, bifurcated at its upper part. Upon the two arms of this core, at *B*, are wound coils of wire connected in multiple, and *C* shows the main coil, through which the current to be measured passes.

At *D*, between the windings *B* and *C*, are placed plates of iron that unite the two parallel branches of the magnetic circuit. Over the disk, at a slight distance above the coil *C*, there is an iron armature, *E*, and it is between the latter and the coil *C* that the aluminium disk revolves. This transformer with three windings creates alternating motor fields of different phases, which act upon the disk and set it in motion. The motor couple is proportional to the power to be measured. There are several interesting methods of regulating this meter. At *P* there is a permanent magnet, above which is an armature, *P'*. This magnet acts as a brake. It is possible to act upon the interposed iron of the magnet by means of the screw *R*. It is likewise possible to act upon the magnet by means of a tappet *S*, which is carried by a spring and may be easily displaced by operating upon the slide *N*.

It is thus possible to cut out a portion of the lines of force of the magnet, and, consequently, to control the operation of the meter. Finally, other very simple and efficient methods of regulation likewise exist. It is easy to displace the iron armature *P'* laterally, and also to act upon the special armature *E* by means of a screw placed above (not shown in the figure). This screw permits of giving the disk a tendency to move, or even a motion in one direction or the other for regulating the proportionality when only small currents are to be measured. This meter is simple, strong, and easily regulatable, and remains accurate whatever be the difference that supervenes between the electromotive force and the intensity of the current. Let us add that it never runs without charge, and that it is extremely sensitive, starting at 1.5 per cent of the maximum charge. The surrounding temperature has no influence upon the constant. The output of power for the running is 1.1 watt for the shunt and 1 watt even when the maximum current is flowing through the principal windings. The meter is small in size.

In order to regulate it, we begin by charging it to three-quarters of the maximum, and then, by means of a chronograph, determine the time, *t*, that it takes the disk to make a certain number of revolutions, *n*. The power in watts registered by the apparatus is equal to the product of the maximum intensity of the meter, in amperes, by the value per 100 volts of the difference of potential, and by the number of revolutions made, divided by the time expressed in seconds. We compare the figure thus obtained with the indications of a wattmeter placed in the circuit. If the difference between the two numbers is less than 2 per cent, the regulation of the meter for this charge is sufficient. If the difference is greater than 2 per cent we then act upon the tappet, *S*, through the intermedium of the screw, *R*, and afterward make a second trial with a reduced current of about a tenth of the maximum. The regulations are then effected by acting upon the armature, *E*.

The type used for triphase currents presents a few peculiarities. It includes two electro-magnets (each of which forms a sort of transformer with three windings) consisting of a U-shaped sheet iron core bifurcated at its upper part, and surrounded at its lower part by two shunt coils, and above by four main coils for the principal current. Between the two coils a sort of magnetic bridge encircles the two branches of the *U*.

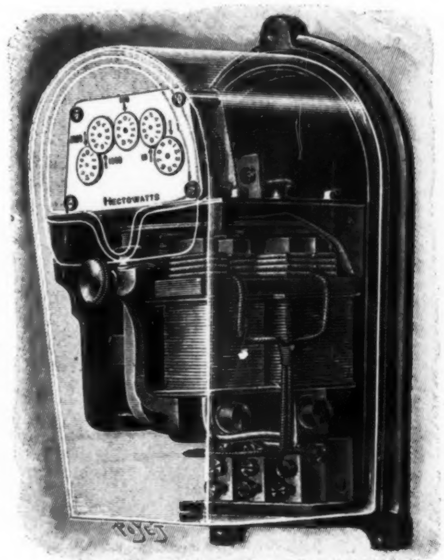


FIG. 1.—INTERIOR VIEW OF BATAULT WATTMETER.

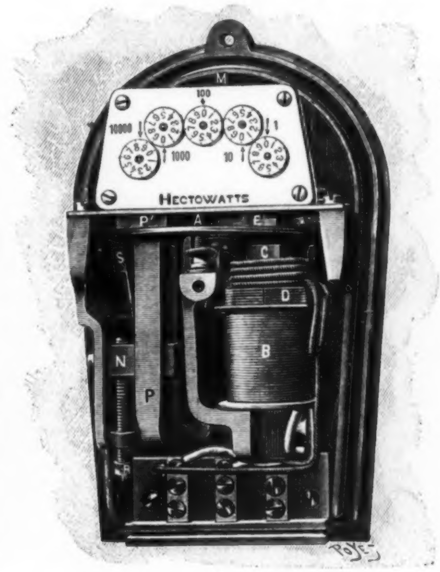


FIG. 2.—INTERIOR VIEW, WITH DETAILS, OF BATAULT WATTMETER.

Above the *U*-shaped cores there are two iron armatures, between which and the electro-magnets the disk revolves.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

RADIUM AND ITS RECENT DEVELOPMENT.*

KNOWLEDGE of radium, the new luminous metal, is gradually increasing. Through the incessant researches of the French savant, M. Curie, assisted by the devoted and persevering co-operation of his brilliant wife, Mme. Curie, information about this substance, hitherto uncertain and but little known, is assuming distinctness and accuracy. The readers of this publication will be interested in these recent conquests of investigating science. I have collected the scattered materials and grouped them into a monograph, which is here presented. At a recent conference with the members of the Institute at Lille, the eminent professor of the Sorbonne made many of his conclusions clear by convincing experiments, which I will describe.

It is well known that certain bodies under suitable conditions become luminous in darkness. It is sufficient if they are subjected to the action of certain radiations; there is phosphorescence, if the radiance lasts for a shorter or longer time, after the extinction of the exciting light; fluorescence, if this brightness lasts only the fraction of a second. I shall not distinguish between these two properties, but shall designate them by the term luminescence, or its synonym, radio-activity.

The number of luminescent substances known is considerable, especially among organic bodies, paper, yellow amber, sugar, silk; but the earthly-alkaline sulphides are particularly luminescent, as for instance, those of barium and calcium, as well as zinc. But luminescence is, first of all, a property of the salts of uranium. M. Curie has conducted laborious researches on the compounds of uranium and barium; pitchblende or uranium oxide (U_3O_8) appears to have attracted his attention especially. Noticing first a very distinct property of radium, that of discharging electrified bodies at a distance, which will be considered later in detail, he proceeded to successive eliminations leading to the concentration of the radiant matter. The increasing rapidity of the discharge of a condenser at a given distance enabled him to determine the degree of concentration. Then he extracted chemically the radio-active bodies already known, uranium in particular, and finally there was left after these successive fractionations a residue possessing a radiant power of unheard-of intensity. By treating one hundred kilogrammes of matter he extracted in this way two decigrammes of radium. For pitchblende, the residue consists of radium, polonium, and a third matter, of which the emitted radiations cannot be compared with those of the first two substances, and differing from these in not being spontaneously luminous.

Are radium and polonium really new bodies? This is difficult to decide. Spectral analysis gives to this hypothesis a character of high probability, which is corroborated by the determination of the atomic weight. The latter increases more and more, and considerably exceeds the atomic weight of barium, with which the residual element appears to be associated. At any rate, polonium behaves as an element much like bismuth. Radium is subject to all the chemical reactions of barium. What enables us to distinguish these two bodies from each other will appear in the course of this article. The properties by which radium manifests its difference from other luminescent matters will be first described. This is the way to prove whether it justly deserves the name of a new metal.

Radium owes its name to the property which it possesses of emitting spontaneously visible rays in darkness. It is well known that invisible rays exist, such as those that confine the violet band (ultra-violet rays) or the red band in the projection of the solar spectrum; certain matters which appear bright in this region alone reveal the existence of these rays; the eye does not perceive them. Therefore certain bodies only are illuminated in the ultra-violet or ultra-red zone—an ephemeral brightness, which disappears some time after exposure to the solar rays. Radium always emits in darkness a perfectly distinct light. Besides, outside of this luminescence of its own, which is shared by its compounds, it has the power of imparting luminescence to others. This is the reason why substances which become phosphorescent under the action of ultra-violet rays are illuminated in the vicinity of radium; on the contrary, substances which become phosphorescent in red light, remain inert near radium. The degree of luminosity depends evidently on the distance from the radiant source. Moreover, radium transmits to certain metals placed under its influence the property of emitting in their turn radiations. This has been called secondary or induced radio-activity; it is analogous with phosphorescence.

These different properties can be very easily proved. A crystal of fluorine or fluor spar, when heated, becomes luminous, by reason of the disengagement of energy accumulated during its formation; then its luminosity ceases. Exposed to ultra-violet rays, it becomes for a moment phosphorescent. Placed near radium, it recovers its luminosity and keeps it more than twenty-four hours; it is truly a regeneration.

Under the radiating action of a particle of radium a screen of platino-cyanide of barium or of tungstate of calcium is lighted up, as it would be in ultra-violet rays.

Zinc or calcium sulphide, when exposed to an intense light, seems to extract from it a stock of temporary luminosity, which may be afterward renewed, but with a facility which is continually diminishing. Near radium, it remains luminous for several weeks, then dies out and loses its phosphorescence permanently. To produce this effect, the two bodies are placed in small flasks, joined by means of a lateral tubulure; the zinc sulphide is very plainly distinguished.

Finally, if the rays of the radium are allowed to fall obliquely on a plate of metal of some thickness, placed above a photographic plate, it will be observed that the part of the plate situated under the metal has received an impression. The secondary radiations produced have therefore traversed the piece of metal in order to excite the other surface.

These experiments are not performed with pure radium, but with a compound inclosed in a sealed glass tube and emitting radiations several hundred thousand times more active than those of uranium. This is a solution which has been carried to the maximum of concentration.

What analogy is there between the rays emitted by radium, the rays emitted by the Crookes tubes, and the ultra-violet rays? The question is difficult to answer.

The Crookes tubes emit two kinds of rays; cathodic rays lodged in the interior, going from the cathode (—) to the anode (+) and propagated like light, in a straight line, but with only half its velocity, and the X-rays or Roentgen rays, which only originate at the points where any matter whatever—solid, liquid, or gaseous—arrests the cathodic rays in their passage. The X-rays in the tube "focus" start therefore from the metal plate of the anode, which the cathodic rays have struck, then traverse the glass and are uniformly distributed in every direction near the tube.

The radium rays possess at the same time the properties of the cathodic rays and of the X-rays. Like the cathodic rays, the rays which emanate from radium are deflected by the magnet; the cathode rays are totally deflected; the radium rays only partially; a part of the rays remain neutral, under the influence of a magnetic field, which leads us to suppose that radium possesses two different species of radiations. In regard to polonium, the action of the magnetic field on its rays is totally null. Its physical character distinguishes it essentially from radium. Cathodic rays and radium rays charge bodies which they strike negatively. Finally, the velocity of propagation of radium rays is also half of the velocity of light.

Like X-rays, radium rays are propagated at a great distance without experiencing any essential diffusion or refraction in passing through the prism. Like them, they are invisible and do not become manifest until they fall on certain bodies which are illuminated by the contact. These bodies, which are affected in the same way by the two kinds of rays, are platino-cyanide of barium or potassium, tungstate of calcium, double fluoride of uranyle and of potassium, and zinc sulphide, which turns phosphorescent, that is, it continues to shine, even when these rays have ceased to strike it. Like the X-rays, they produce in certain metals a secondary luminescence equally invisible, which is only revealed at the approach of the bodies mentioned. Like them, finally, they traverse opaque bodies, leave impressions on the photographic plate, discharge at a distance electrified bodies, and exert on the skin a physiological action, making them suitable for medical and surgical applications, as in the treatment of lupus.

Ultra-violet rays have properties identical with those of the X-rays and radium rays, with the exception, perhaps, that the ultra-violet light discharges especially negatively-charged electric bodies, while the Roentgen rays act equally on negative or positive electricity. So that it may be said that radium is a Crookes tube constantly excited and emitting, like it, ultra-violet rays.

But what is then the characteristic quality of radium which may explain the increase in research and the growing curiosity of which it is the object? Its prodigious activity.

As was stated at the outset, the other bodies emit visible rays only under the influence of special radiations, and are extinguished when the exciting light disappears; this emission takes place with radium without any previous insolation; besides, this is as nothing, when considering the enormous quantity of invisible radiations which it contains. Certain other matters can also be the center of invisible light; they have stored from the moment of their origin a stock of energy which they slowly expend in the form of invisible radiations; at length this property passes away, while with radium it remains. Exceptional intensity of action, indefinite duration of action, are its two remarkable qualities.

The residue called radium by M. Curie possesses a radio-activity at least two hundred thousand times greater than that of uranium; this latter metal is on a small scale what radium is on a grand scale; with the exception of the degree of intensity the emitted rays have the same properties; uranium is like a small Crookes tube.

Uranium takes a considerable time to discharge electrified bodies; a few decigrammes of radium placed in a glass tube produce this effect instantaneously. M. Curie demonstrated this fact to us by means of two experiments. An electroscope received from the Volta electrophore an electric charge, causing the gold leaves to diverge. These were projected on a screen, where their reversed image was considerably enlarged. A fragment of uranium brought very near the ball of the instrument did not produce any perceptible effect; at a distance of more than forty centimeters,* the tube containing radium caused the divergence of the leaves to cease immediately, and they approached each other. In the dry air the divergence of the leaves would have lasted several days; radium communicated to the surrounding air the property of conducting the electricity, and on account of this conductibility, the accumulated fluid was immediately disengaged from the apparatus, which became neutral. This conducting power given to the air by radium was still better recognized in the second experiment.

The extremities of the secondary wire of an induction coil were terminated in two pieces of apparatus, constructions in the form of the letter T, producing the bifurcation of the circuit; one was furnished at each of its extremities with two balls, or rather with two points turned within. The two constructions being parallel and the points opposite, the spark exploded with equal frequency between the points. In order that the difference might be more considerable at one point than at the other, the explosion was produced at only one point. Everything being arranged, the precious case containing the radium was brought near the other point and immediately provoked the spark; the air having become a better conductor in this region, the explosive distance was thus very much increased.

If the chemical effects of the radiations of radium are considered, they will be found to resemble in part those of the light; they leave an impression on gelatino-bromide plates, split iodic acid into iodine and oxygen, convert white phosphorus into red phosphorus, etc. These radiations also traverse opaque bodies in the visible light, which places them in the same order with the X-rays. M. Curie projected for us very distinct radiographs obtained by means of radium.

It is evident that the radium rays have a character of their own distinguishing them from others. Thus, for instance, they color certain chemical products, and after a while they blacken the glass flask inclosing the precious metal which originates them. Here we observe a more energetic chemical action modifying the constitution of the glass. The lead entering into its composition in the form of a salt becomes again metallic by reduction and thus blackens it. By oxidation, on the contrary, the glass would turn blue, if there should be manganese in its composition.

The physiological properties of the radium rays are especially remarkable. While the prolonged application of X-rays produces on the skin a simple erythema causing perhaps a falling of the hair, radium produces a veritable burn, an almost irreducible burn; it yields only to a treatment of six months. M. Becquerel was accidentally the victim of these deadly rays, by carrying in his pocket a tube containing a few decigrammes of slightly active radiant matter. M. Curie voluntarily, in the cause of science, devoted himself with true heroism to their cruel attack and sacrificed a part of the skin of his arm. The direct contact of radium causes in a short time a dropping off of the skin, followed by severe, persistent pain. The vegetable world is as susceptible as man. The seeds of mustard and garden cress, exposed to the corrosive influence of radium, lose their germinating power.

This is wonderful, but not so astonishing as the fact that all these different effects, some more singular than others, are produced by a single particle of metal through a double covering of glass, without this magic power being diminished by time. It appears from reliable calculations, that with radium, the loss of substance, caused by the radiating energy, for one cubic centimeter, would be one milligramme in a thousand million years.

What in this case becomes of the fundamental law of the conservation of energy? If nothing creates itself, how is it possible to explain this constantly renewed power of emitting rays? For even light, visible or invisible, is only a form of energy, which must be derived from some source. Here we must acknowledge that science is baffled and lost in conjectures. Radium may be an accumulation of energy; it may collect it from the surrounding air, from the bodies in its vicinity. This is but a hypothesis, like that of "dissociated atoms" for explaining "black light." The same explanation may be given here: the particles resulting from this dissociation of the atom being infinitely great compared to the atom itself, radium might emit some indefinitely without losing essentially of its weight. As they conduct electricity and as the invisible radiations are formed of it, it will be understood why these radiations are deflected by the magnet, why they make the air, and even liquids, conductors of the current. Doubtless this theory is wonderfully clever; it cuts delightfully the knot of the difficulty. But we will take the liberty of waiting for results more conclusive.

SOME POPULAR ERRORS IN REGARD TO THE EYES AND EARS.

IN a recent number of the National Druggist, a few comments are made on some current superstitions with regard to the eyes and ears.

A great many, perhaps the majority of otherwise well-informed people, believe that they see the same with both eyes—or, to put it more in accordance with the facts of the phenomena of vision, that the image formed on the retina of each eye is identically the same—presupposing, that is, that both eyes are in normal, healthy condition. That this is not the case, one can easily convince himself by the following simple experiment. Cover one of the eyes with the hand or a bandage, and let the experimenter attempt to snuff out a candle suddenly placed within a few feet of him. He will almost invariably miss the flame, either over-reaching, underreaching or putting the fingers too far to the right or left of the flame. With both eyes normal and open the accommodation for distance and direction is instantaneous.

Dipping the pen into an inkstand on the table before one is an easy matter, when he has the use of both eyes, and specially if he, like the writer of this, has sat at the same table for many years, writing for several hours each day. Let this person be suddenly deprived of one eye, and he will find that until he grows accustomed to it, he will not touch the mouth of the inkstand at first trial once in a dozen times, but, as in the case of the candle, will fall short, but a little later on he will habitually overreach the desired spot, and it takes long practice to be able to correctly place the hand. The reason for the apparent reversal of habit noted above, the change from under to overreaching, is very easily explained—the observer, bearing in mind the tendency to fall too short, purposely lengthens his reach, and in so doing reaches too far. The writer hereof was several months in overcoming this difficulty, and even yet, after the lapse of six years' experience, finds considerable difficulty in locating the exact distance and direction of small objects, say a pin, or a pen lying on the table before him.

Another fallacy under which the majority of persons labor is that the loss of one eye strengthens the vision of the other—an idea originating in the fact so often noted that the complete loss of one of the senses is frequently, if not always, compensated by an increment in the delicacy or acuteness of another—thus, when the sense of vision is lost, the sense of touch, or that of hearing, or of both, frequently becomes more acute, sometimes to a marvelous degree, if we may believe the many well-attested instances on record, and some of which, no doubt every reader will recall.

So, too, generally, it is in the loss of a limb, espe-

* From the French of Prof. Cyr Wattiez of the Institut Technique, in L'Industrie Textile. Specially translated for the SCIENTIFIC AMERICAN SUPPLEMENT.

* The invisible light emitted by radium follows, however, like the visible light, the law of the square of distances.

cially of an arm; the remaining limb, the muscles of which, by having to do much more work, grow harder and stronger, as, doubtless, they would under the same amount of work were the other limb remaining intact.

With the organs of sight, or of hearing, where the duplication of the member serves certain definite purposes or ends, the loss of one weakens and to a certain extent, incapacitates the remaining member. Thus, with the two eyes in normal working order we can estimate the exact position and approximate distance of any object looked at, but when only one eye is in use, as we have seen in the experiment with the candle, we can not do so. The same phenomena occur in the loss of audition in one ear. The sound is heard by the remaining ear, but the hearer fails to be able to locate the direction whence the sound proceeds, nor can he ever entirely overcome the difficulty.

If we have two persons employed to do a certain piece of work, which their joint co-operation is necessary to accomplish properly, we would not remove one of them and expect the remaining one to perform the work either as easily or as satisfactorily as when both labored together, nor should we expect that a man with one eye, or one hearing only on one side, to be able to see or hear as well as one whose vision or hearing is in normal condition.

THE ATOMIC THEORY AND THE DEVELOPMENT OF MODERN CHEMISTRY.

MANCHESTER celebrated just a little prematurely the centenary of John Dalton's atomic theory. It was on September 6, 1803, that he drew up in his notebook his first table of weights of the "ultimate atoms" of hydrogen (which he took as his unit), oxygen, "azot," carbon, sulphur, and of water, ammonia, nitrous gas, nitrous oxide, and other binary compounds of these elements. With regard to the genesis of the theory in his own mind much doubt has prevailed until recently. Dalton himself told Thomas Thomson in 1804 that he had been led to the theory from his work on marsh gas and olefiant gas. He told W. C. Henry in 1824 that his speculations were suggested by the work of Richter. And yet, oddly enough, as Sir Henry Roscoe and Dr. Harden have shown in their "New View of Dalton's Atomic Theory," the evidence is dead against the accuracy of these plausible statements. Dalton's own notebook shows that his atomic theory preceded his work on marsh gas, and his notes for a lecture delivered in 1810 give a history of his ideas which agrees with all the facts.*

It was from Newton that Dalton derived his belief in the atomic hypothesis. And we can trace the "solid massy, hard, impenetrable, movable particles" of Newton, through his friend Boyle, ~~through Gassendi~~, and through Bacon (who considered Democritus to be the greatest of Greek philosophers) back to Epicurus and to the originators of the atomic theory, Democritus and Leucippus. Dalton's theory of atoms is historically the Greek theory of atoms. But with a difference.

Boyle, who was a far more thoroughgoing atomist than is generally supposed, really rejects the hypothesis of different elements which he himself originated, considering that differences of atomic structure and arrangement of a single form of matter would account for all chemical transformations.†

But Boyle's own definition of an element, as a substance which could not be decomposed, proved far more fruitful than his atomic beliefs, and the work of his successors—of Marggraf, of Black and Cavendish, of Scheele and Bergman, of Priestley and Lavoisier—had gradually established in the minds of chemists the idea, rejected by Boyle, that there existed a series of elements not convertible into one another. It was to that series of elements, unknown to the ancients, that Dalton applied the atomic hypothesis. He came to the conclusion that the atoms were not of all kinds of shapes and forms, as had been previously supposed, but that the atoms of the same element were all identical in weight, while the atoms of different elements were different in weight. It was an idea that might conceivably have occurred to some chemist fifty years earlier. But, in spite of Black's work, the phlogiston theory had led chemists before Lavoisier to lay small stress on the notion of weight. Dalton could hardly have come much earlier than he did. The first announcement of his theory was made in a paper read in October, 1803, at a meeting of the Manchester Literary and Philosophical Society, in the house of which he had his laboratory; the paper was not published until 1805. Dalton's views were not fully placed before the world until the publication of the first volume of his "New Systems of Chemical Philosophy," in the years 1808-1810.‡

Meanwhile Dalton had been carrying out researches which confirmed his view, and, together with certain assumptions, led to the most important of generalizations. Dalton himself never disengaged the facts from the theoretical language in which he clothed them. But we may say, broadly speaking, that Dalton's atomic theory led to the establishment of three fundamental laws of chemistry, the law of definite proportions,§ the law of multiple proportions (which really includes the law of definite proportion) and the law of equivalents. The fact that elements unite in more than one ratio by weight obviously made further assumptions necessary, over and above the atomic hypothesis, before any table could be drawn up of relative atomic weights. Dalton seemed to have felt no hesitation in making the assumptions that seemed to

* Save for an obvious clerical error of 1835 for 1808.

† "I see not, why we must needs believe, that there are any primogeneal and simple bodies, of which as of pre-existent elements, nature is obliged to compound all others. Nor do I see why we may not conceive, that she may produce the bodies accounted mixt out of one another by variously altering and contriving their minute parts, without resolving the matter into any such simple or homogeneous substances, as are pretended" ("The Sceptical Chymist," part vi., folio edition, vol. i., p. 309). See also p. 306, a reference to an experiment by which Boyle thought he had "destroyed refined gold and brought it into a metalline body of another colour and nature"; and p. 307, an earlier announcement of the view just quoted.

‡ The first part of this volume appeared in 1808, the second in 1810. The first part of the second volume only appeared in 1827. The work was not completed.

§ The present writer has briefly discussed the history of this law, in Nature, vol. l., 1894, p. 149.

him convenient ("New System," part i., p. 214). But Wollaston, while giving Dalton's theory his powerful support, showed, in 1814, that Dalton's assumptions were arbitrary, and Wollaston's term "equivalent," which was regarded as implying no hypothesis, soon became a serious rival to the term "atomic weight." Davy, to whom (with Henry) Dalton had dedicated part ii. of the "New System" in 1810, gave Dalton's views a reception more than cool.*

Among the great chemists of the day, it was to Berzelius, who had already been trying to extend the quantitative work of Richter, that Dalton's views appealed most. But Berzelius, less imaginative, but more critical a thinker and more accurate a worker, than Dalton, saw that much remained to be done before the theory could be placed on a satisfactory basis. "I think," he writes to Dalton, "that we must let experiment mature the theory." Berzelius's admirable "Essai sur les Proportions Chimiques" of 1819† gives the first critical account of the atomic theory, while the experiments recorded therein may be regarded as having first placed the laws of multiple proportions and of equivalents on a sufficiently wide basis to be regarded as generally valid.

Nevertheless, the conviction that chemistry could do quite well without the conception of atoms, and that the notion of "equivalents" was sufficient, grew steadily; between 1840 and 1850 Leopold Gmelin's system of equivalents came to be accepted almost universally.‡ It was the growth of organic chemistry and the confusions of organic chemistry which the "equivalent" conception was powerless to remove that restored the notion of the atom. From 1842 onward Laurent and Gerhardt, those two Ishmaels of their day, fought indefatigably for the establishment of some consistent theory of organic compounds; and they reached consistency only by reviving the simple molecular hypothesis of Avogadro and Ampère.§ This hypothesis gave them at once an experimental method for the determination of the relative molecular weights of all volatile compounds; and it gave them simultaneously a method for determining maximum values for the atomic weights of the elements therein contained, for obviously each molecule must contain at least one atom. But neither they, nor Cannizzaro later, were able to give any simple rule applicable in all cases to the determination of atomic weights. The atomic weight of carbon on which the reform of Laurent and Gerhardt pivoted, was an exception to the rule of Dulong and Petit on which Cannizzaro, with general approval, has laid so much stress. But a hypothesis may be useful without being perfect. The atomic hypothesis in the hands of Wurtz, Hofmann, Williamson, Frankland, Kekulé, and Baeyer, and with the most brilliant and essential but involuntary help of Berthelot and of Kolbe, was the instrument which served to build up modern organic chemistry. It gave chemists an unforeseen mastery over the elements; the synthesis not only of the natural organic compounds, but of an infinity of new ones seemed to be brought within their reach. In this development Manchester had again played a part of first-rate importance. Frankland's theory of valency was based on his researches on the organometallic bodies carried out in the Owens College, where he was professor, and published in 1852. The exact *rôle* of Frankland's work on valency (neglected at first by most chemists) was this: it forced his friend and fellow worker, Kolbe, to abandon the Berzelius copula theory, and led him to build up "constitutional" formulæ for the chief alkyl compounds so near our own that he was enabled to predict from them the existence of secondary and tertiary alcohols. The formulæ of Kolbe, with the atomic weights of Gerhardt, again led inevitably to the great theories of Kekulé on the tetravalency of carbon and the linking of the atoms, which are now regarded as fundamental in organic chemistry.

In 1875, new horizons were brought into view, Wollaston predicted of Dalton's atoms in 1808 that "the arithmetical relation alone will not be sufficient to explain their mutual action, and that we shall be obliged to acquire a geometrical conception of their relative arrangement in all the three dimensions of solid extension." Le Bel and Van't Hoff, by their work on the "asymmetric" carbon atom, created a new "chemistry in space," of which one of the most striking results has been the beautiful synthesis of the sugars, by Emil Fischer and his fellow workers. Prof. Pope has recently extended these new ideas to inorganic chemistry with brilliant results.

But such exceptional results as those of Prof. Pope bring sharply into view the fact that the direct service of the atomic theory to inorganic chemistry has been relatively small. What, for instance, has the theory of valency to tell us about such a series of compounds as the tungsten chlorides discovered by Roscoe? But if the atomic theory has helped us comparatively little in determining the constitution of inorganic compounds,‖ it has contributed to our discovery of new inorganic elements. The attribution of certain numbers, equivalents or atomic weights, to the elements led naturally to speculation on mathematical relationships between them. Many of these speculations, like the original one of Prout in 1815, and that of Dr. Henry Wilde, of Manchester, more recently, were suggested by the fascinating question of the fundamental unity of all matter. Are the elements really compounds of one original matter—the *protyle* of the Greeks revived by Prout and by Sir W. Crookes? If so the atomic weights must have some common measure. On the accurate determination of atomic weights, made largely to settle this question, infinite pains have been spent by Stas, Marignac, Richards, and many others. On the criticism and accurate calculation of results from these experimental determinations infinite pains have again been spent, by Meyer and Seubert,

* In two unappreciative lines in a footnote to the "Elements of Chemical Philosophy," published in 1812 (see p. 78 of the edition of 1860).

† The Swedish edition appeared earlier.

‡ Gmelin himself in his "Handbook of Chemistry" inclined to the atomic theory. English edition, translated by H. Watts, vol. i., p. 42.

§ "Equal volumes of all gases under the same conditions of temperature and pressure contain equal numbers of molecules."

‖ The researches of Divers and of Raschig on certain sulphur and nitrogen compounds may be regarded as examples of what may be done in this direction.

and above all by Prof. F. W. Clarke, who delivered the Wilde lecture of the Manchester Literary and Philosophical Society at the centenary celebrations.

But though certain numerical relations seem striking, chemists are certainly as a body not inclined to acknowledge the existence of any exact formula expressing as a mathematical series the series of the atomic weights.

More immediately fruitful of results have been speculations less fundamentally ambitious. The schemes of Lothar Meyer and Mendeleeff, according to which the elements, when arranged in the order of their atomic weights, take their place on a kind of chessboard, elements resembling one another being in the same row, have led to the prediction of the existence of new elements; and even unpredicted new elements, such as the remarkable series discovered by Lord Rayleigh and by Sir William Ramsay, have had a fairly comfortable place found for them by extending the chessboard on ground to which it had some legitimate claims.

Inorganic chemistry has developed recently very largely on the physical side. In much of the work, notably in the applications of thermodynamics (and especially of the researches of Willard Gibbs, whose death we lament), the atomic theory plays no part, or but a small one. In the great studies on solutions, however, originated by Van't Hoff, Arrhenius, and Ostwald, the fruitful *ion* theory formulated by these chemists can hardly be regarded as independent of the atomic theory. And yet, in his last book on inorganic chemistry, Prof. Ostwald employs "the forms of the atomic hypothesis as sparingly as ever the present use of language will permit."*

In what has preceded, the atomic theory has been regarded from the point of view of utility. Of its utility to chemistry there can be no doubt. It helps us to describe complicated phenomena briefly. The atomic formula CH_3COOH reminds organic chemists at a glance of a very large number of properties of acetic acid. But, many will ask, is this atomic theory something more than useful? Is it really true?

The subject has been much discussed of late both by men of science and philosophers.† One school regards the methods of experimental science as capable of yielding generalizations that are absolutely true, and some of the members of this school do not hesitate to say that the atomic theory is absolutely true. Sir Arthur Rücker concluded his brilliant address to the British Association in 1901 by declaring that "we have a right to insist—at all events till an equally intelligible rival hypothesis is produced—that the main structure of our (i. e., the atomic) theory is true; that atoms are not merely helps to puzzled mathematicians, but physical realities." Even in this most positive assertion of Sir Arthur Rücker with regard to the existence of atoms there remains a shade of doubt. Lord Kelvin, in a subsequent speech, showed that in his mind, at any rate, there was none.

There is, however, another school, the origins of which go back far, but which is identified chiefly with Kirchhoff (the discoverer with Bunsen of spectrum analysis), and with his disciples Mach and Ostwald in Germany, and Karl Pearson in England. According to this school, the discovery of "causes" and of ultimate truths is not the business of experimental science. The object of science, according to Kirchhoff, is to describe natural phenomena in the simplest way possible. If a theory like the atomic theory helps us to describe observed phenomena more simply and to discover new ones, let us use it by all means. But (they would say) since the existence of atoms cannot be verified directly‡ it is really useless for scientific purposes to discuss whether the theory is true or not. Obviously, science here abandons those claims to finality which have been insisted on so strongly by the older and more orthodox school, for our simple descriptions are liable at any moment to be replaced by descriptions still more comprehensive and still more simple. It would be hard indeed to prove that any given theory has attained a maximum of simplicity in summarizing the facts with which it deals.

Kirchhoff's self-denying ordinance on the part of science, leaves, no doubt, a wider field open to the metaphysicians. But *qui trop embrasse mal étreint;* and the limitations of scientific claims which he advocates may well strengthen science in her own proper borders.

The atomic theory has had a long and venerable history; the "solid, impenetrable" particles of Newton were originated by the Ionian philosophers in the fifth century B. C. A hundred years ago the genius of Dalton gave the theory a fresh and still unfinished career of usefulness, and whether we consider it in the light of a truth that cannot ever disappear from science, or rather as an engine serving to fashion and unite our ideas, possibly to be replaced later by an intellectual mechanism still more efficient, our debt to Dalton remains one of the greatest that the world owes to its great men.—P. J. Hartog, in Nature.

* "Principles of Inorganic Chemistry." Translated by A. Findlay, 1902, p. 146. (Macmillan and Co., Ltd.)

† See Prof. James Ward's "Naturalism and Agnosticism." 2 vols., 1899.

‡ "No physicist or chemist can produce a single atom separated from all its fellows and show that it possesses the elementary properties he assigns to it" (Sir A. Rücker, *loc. cit.*)

PUBLIC SERVICE OF RAILWAYS.

THE number of passengers carried during the year ending June 30, 1902, as shown by the annual reports of railways, was 649,878,505, showing an increase for the year of 42,600,384. The number of passengers carried one mile—that is, passenger mileage—was 19,689,937,620, there being an increase in this item of 2,336,349,176. There was an increase in the density of passenger traffic, as the number of passengers carried one mile per mile of line in 1902 was 99,314, and in 1901, 89,721.

The number of tons of freight carried during the year was 1,200,315,787, an increase of 111,039,347 being shown. The number of tons of freight carried one mile—that is, ton mileage—was 157,289,370,053. The increase in the number of tons carried one mile was 10,212,234,013. The number of tons carried one mile

per mile of line was 793,351. These figures show an increase in the density of freight traffic of 32,937 tons carried one mile per mile of line.

The report contains a summary of freight traffic analyzed on the basis of a commodity classification, and also a summary indicating in some degree the localization of the origin of railway freight by groups of commodities.

The average revenue per passenger per mile for the year ending June 30, 1902, was 1.986 cents. For the preceding year it was 2.013 cents. The revenue per ton of freight per mile was 0.757 cent, while for 1901 it was 0.750 cent. An increase in earnings per train mile appears both for passenger and freight trains. The average cost of running a train 1 mile also increased. The percentage of operating expenses to earnings was 64.66 per cent.

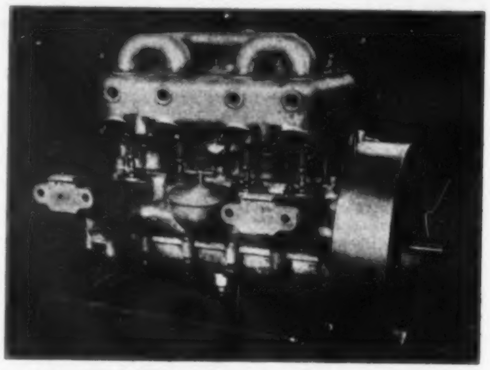
[Continued from SUPPLEMENT No. 1437, page 23029.]

SOME DETAILS OF THE PARIS-MADRID RACING AUTOMOBILES.

Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT by our PARIS CORRESPONDENT.

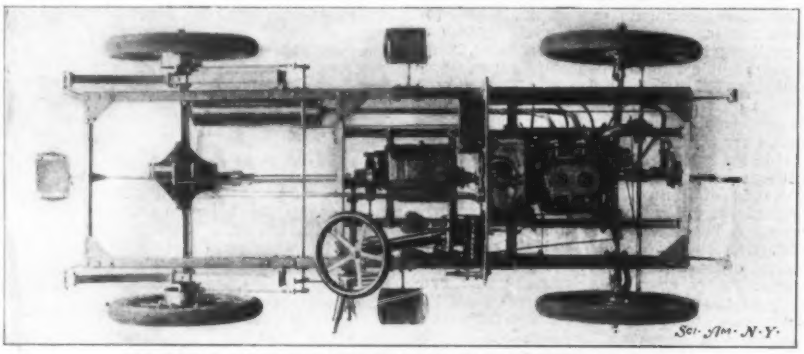
IV. THE PASSY-THELLIER AND CLEMENT VOITURETTES.

IN the voiturette class, whose weight is limited to 880 pounds, the Clement and the Passy-Thellier may be taken as examples. The latter is one of the new makes, but has already made a good record. The photograph shows that four of the racers arrived in good condition at Bordeaux. Another view represents the chassis of the standard machine, which has been but slightly modified for the racing cars. The framework of the latter is built of steel tubes. The motor, of the 2-cylinder type, is mounted, together with the change gear box, upon a separate frame, which is bolted to the chassis. This makes the motor solid with the friction clutch and speed-changing box, and gives a more rigid construction. The case which contains the speed-changing gears is placed directly under the floor in the front of the car, so that it can be easily inspected without the operator being obliged to go underneath. It is provided with three speeds and a reverse by sliding gears, with a direct connection to the rear shaft at full speed. From the gear box, the power is transmitted to the differential by a jointed shaft of some length, which has a square socket at each end. The differential is provided with two brace rods which are mounted on springs, and, owing to this device and to the sliding sockets of the transmission shaft, the shocks of the road are taken up to a great extent and the differential keeps its position. The latter is easily accessible, being placed under the rear flooring. One feature of the differential is that it has a set of thrust bearings in the interior which are easily regulated and can be inspected *en route* to observe the working and take up the wear when necessary. In the racing machines, owing to the pointed front which is adopted, the radiator is placed in front and below the body of the car. The water circulation is obtained not only by a turbine pump, but the water tank is disposed so that the water can circulate on the thermo-siphon principle, so that if the pump should fail to work, the cooling, although not so rapid, will still take place, and will be a valuable help in case of accident. All the working parts, motor, change-gear box, and rear mechanism are oiled automatically. The friction clutch for throwing the motor into gear is operated by a pedal, while a second pedal operates a brake upon the differential and at the same time unclutches the motor. A band brake upon the rear wheels is also worked by a lever, which uncouples the motor at the same time.

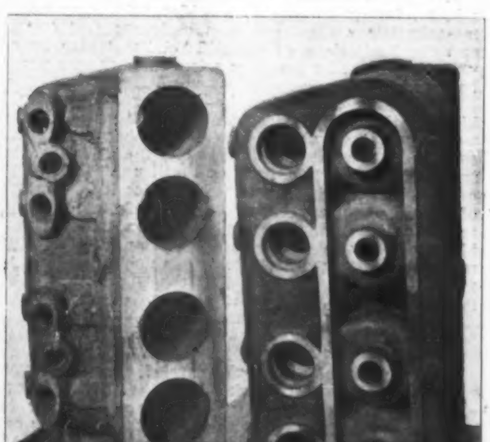


THE 12 HORSE POWER MOTOR OF THE CLEMENT VOITURETTE.

The Clement voiturette, which made the highest speed in its class, covering the 300-odd miles from Paris to Bordeaux in 7 hours, 19 minutes, and 57 1-5 seconds, was shown in the SCIENTIFIC AMERICAN of June 20. As this machine is constructed on the same lines as the preceding, as regards the general arrangement of the parts, it will only be necessary to illustrate a few of the new features of the details. The 12 horse power, 4 cylinder motor, a view of which is shown on the side next the valves, has been designed specially for the racing machine. A novel feature is the method which has been adopted for constructing the water jackets. As shown in another view, the four cylinders, water jacket, and valve seats have all been cast in one piece, which simplifies the construction considerably. To the left is the same casting viewed from the bottom, showing the cylinder bore. In ordinary cases it would be unadvisable to surround all four cylinders by a common water-jacket, as in case it should leak the whole motor would be thrown out of use, while by mounting the cylinders in pairs, as is usually done, there is always one pair in reserve; but for the short trip made by the racing machine this construction can be used very well, and it has the advantage of great solidity and lightness. The pairs of valve seats at the top of the cylinders will be observed. All four valves (inlet and exhaust) are operated from a cam shaft which is inclosed in the case. Between each pair of valve openings is the attachment for the water pipe. The crank-case of aluminium is cast in two pieces, bolted together in the middle. The upper part carries four stout arms by which the motor is bolted to the chassis. On the right is the flywheel, the interior of which is turned out to form the cone of the friction clutch. The transmission is made as in the preceding case from the clutch to the change-gear box, and thence to the differential on the rear axle by a universally jointed rod.



CHASSIS OF THE PASSY-THELLIER VOITURETTE.



THE FOUR CYLINDERS AND WATER JACKET OF THE CLEMENT VOITURETTE, CAST IN ONE PIECE.

FOUR PASSY-THELLIER RACERS AFTER THEIR ARRIVAL AT BORDEAUX.

DETERMINATION OF TEMPERATURE IN BORINGS.

IT is known that the measure of temperatures in drillings serves to determine the geothermic degree; thus is designated the extent of the depth in the earth, when the temperature increases one degree. For the measuring of temperatures at different depths, the geothermometer is generally used. This apparatus is ordinarily composed of a mercury thermometric tube of great capacity, which is open at the upper end.

In order to utilize the instrument, the thermometric tube is filled with mercury at a temperature lower than that of the excavation, then the tube is let down into it; the temperature rising, the mercury is dilated, and the quantity in excess runs over into a small glass bowl provided for this purpose. Then the apparatus is drawn to the surface. The mercury on cooling descends in the tube and is placed in a vessel of water with a standard thermometer graduated to the tenth of a millimeter. The water is slowly heated; and the level of the mercury reaches the height of the first thermometric tube. The temperature of the cavity in the earth will be the temperature which is indicated at this moment by the standard thermometer.

This is the old method, employed by Köbrich in several excavations in Germany. M. H. Thumann has more recently applied simpler methods, especially in borings at Oldau, of which we shall speak later.

It must be remarked that deep borings are always full of water, which at the bottom is warmer than the water above; it is lighter and tends to mount upward. It will therefore be always in motion, and if special care is not taken the indication of temperature will be too high. In order to remedy this inconvenience, Köbrich fitted joints of clay or caoutchouc between the different tubes; the cavity was in this way made impermeable, the water was baled out and the temperature could be taken by letting down the geothermic apparatus.

But this operation was tedious; the apparatus had to remain in the excavation some ten or twelve hours before it could well take the temperature of the sides. If the time for bailing and for working the apparatus is also taken into account, it will be seen that the boring for a depth of 1,500 meters would cause an interruption of the work for from twenty-four to thirty-six hours.

M. Thumann has been able to operate in a simpler manner at Oldau for extracting magnesium chloride, a boring which has reached 1,613 meters in depth. The process of this engineer reduces very much the loss of time and the consequent expense.

Accurate measuring is much easier when the water at the bottom is of more uniform temperature. For this purpose the upper part of the pit must be brought to a lower temperature, in the neighborhood of that at the bottom. That may be accomplished with little trouble. It is only necessary to bend back the boring tube which is on a level with the ground and immerse the extremity in a tub of water; this water is then heated by means of a steam jet provided by the machine which serves for boring.

M. Thumann made use of a strong cylindrical vessel of metal, having a cover of cigar form. The vessel and cover were threaded on the outside for screws. A ring of copper was screwed on, which excluded the water. The apparatus was let down a depth of 1,600 meters to the bottom, which was full of a solution of sodium chloride, corresponding to a pressure of 217 atmospheres. When the apparatus was drawn up, it was found that not a drop of water had penetrated. In this apparatus was placed a board, which was kept from moving by woolen disks. The board had three cavities, into which three mercury thermometers were placed, checking each other. These thermometers were likewise kept from moving by woolen plugs.

The apparatus thus constructed was dropped into the excavation. The water at the bottom completely deadened the fall. At the bottom the water is denser and

contains mud sediment of all kinds in suspension; thus the apparatus reached the bottom gently and sank a little into the earth. It was left there from five to ten hours before it was drawn up, so that it might take the temperature accurately. At each test, it was ascertained that the temperature was higher than the temperature of the water which had been bailed out.

In another boring near Oldau, a boring made in order to study the formation of various saline strata, a depth of 1,613 meters was reached. The pipes at their extremity had a diameter of 112 millimeters. This great work occupied nine months.

The patience of the Germans who undertake such laborious work is worthy of admiration.—Translated from L'Echo des Mines et de la Metallurgie for the SCIENTIFIC AMERICAN SUPPLEMENT.

DISCOVERY OF A ROMAN PALACE AT CARTHAGE.

DURING the course of a visit that the Queen of Portugal recently paid to Carthage, Baron Anthouard, delegate to the general residence of Tunis, showed her Majesty the discoveries that the service of Antiquities is now making upon the east side of Odeon Hill. It is here that the force under the direction of M. Gauckler is at work unearthing a luxurious Roman palace constructed, according to all appearance, at the close of the first century of our era upon the site of an ancient cemetery dating back to the time of the Punic wars.

ONE OF THE HALLS OF THE ROMAN PALACE OF CARTHAGE.

The plan of the habitation, which is as yet but half freed from rubbish, appears nevertheless with sufficient distinctness to permit us to see the relation that it bears to the Greco-Roman house of Pompeii and the curious analogies that it presents with the modern Moorish structures of Tunis.

The front door is situated on the side toward the sea, and gives access to a wide vestibule analogous to the Arabic "skifa." The apartments are grouped around a square peristyle surrounded by a covered portico paved with mosaics, and the rose-colored marble columns of which, surmounted by capitals of white marble, are still in place upon their bases.

The middle of the court was open, with a central garden having the form of a regular octagon. Between the garden and the portico, the intermediate space was occupied by an admirable mosaic of the best style representing a sort of aviary in which a hundred different birds are sporting in a flower garden strewed with branches loaded with fruit. Here are peacocks lazily trailing their ocellated tails upon the ground, golden pheasants, and rose-colored flamingos; and there are swans and geese forming an astonishing symphony of white upon the white ground of the picture, while ducks, partridges, and cocks are seen pecking at pomegranates. Again, there are a few quadrupeds, such as tame gazelles, jerboas, and hedgehogs; while lizards, a chameleon, and a grasshopper complete the population of the aviary and make the mosaic resemble a colored plate detached from an atlas of natural history.

At the four corners of the court, in the center of the triangles, were planted trees, such as lemon trees and pomegranates, which rose through holes in the pavement formed for the purpose.

The apartments, distributed around the central court upon a horizontal plane that intersects the slope of the hill, are more or less well preserved according to the depth of the artificial earth that has protected them against the vandalism of searchers for building stone. They were all paved with various mosaics. Their walls were inlaid with marble representing light foliage of a pale color upon a ground of dark green or red.

The richest halls are as yet but half freed from rubbish. One of them has preserved its walls, which are covered with frescoes of a severe geometrical style up to a height of 12 feet. A magnificent decorative mosaic, which recalls the most beautiful pavements of the Villa Hadriana, at Tivoli, spreads out its volutes and its foliage, in which the acanthus and grape vine are combined, over a surface of 375 square feet.

The Roman palace of Carthage covers a series of tombs that date from the Punic epoch and that have remained up to the present inviolate. These are funeral chambers, sometimes superposed, which were dug to a depth of from 23 to 33 feet in the compact clay of the hill, and were reached through a rectangular funeral shaft. In them is found a curious mixture of the processes of inhumation and incineration, which were simultaneously employed in the latter days of Punic Carthage. The same funeral chamber contained a heavy sarcophagus of tufa inclosing a skeleton bedecked with gold jewelry, and, above, a limestone box containing nothing but ashes.

From one of the tombs opened before the eyes of Queen Amelia were taken numerous articles of pottery, jars, perfumery burners, lamps, coins, bronze mirrors, enamel beads, ostrich eggs, and, in a word, all the funeral furnishings characteristic of Carthaginian sepulchers contemporaneous with the epoch of Hannibal.—Translated from L'Illustration for the SCIENTIFIC AMERICAN SUPPLEMENT.

INVESTIGATIONS AT ASSOS.*

THE site of Assos is an isolated volcanic hill more than 750 feet in height, lying on a narrow strip of land only about a mile wide, between the river Satnioïs and the Gulf of Adramyttium, opposite Lesbos, on the southern shore of the Troad, about thirty miles from Troy. The small summit of the hill, on which are seen no indications of any ancient building except a temple, was the crater of the volcano, choked by a second flow of andesite which has well covered the limestone at the foot of the hill. The temple was as conspicuous as that of Sunium—"Colonna's marbled steep"—rising as it did far above the city, and the position of the city was marked and commanding. Before the foundation of Alexandria Troas, about twenty miles distant, near the close of the fourth century B.C., Assos seems to have been the chief city of the Troad after the fall of Ilium. Its harbor was artificial, being formed only by a mole, of which a large part has now nearly or entirely disappeared; but for a thousand years the place has had no importance except for this slight shelter of ships. The Apostle Paul went on foot from Troas to Assos, and there joined his companions, who had journeyed by sea. At present the Turkish village of Behram on the slope of the hill is made up of a hundred miserable huts; but fifteen or twenty boats are generally at the mole receiving their lading, which consists chiefly of the husks of the acorns of the valonia oak, which are brought to the port on the backs of camels and are exported for use in tanning. The wheat for which the region was so famous that it was used for the bread of the Persian king's table, two thousand miles away, is not now raised in sufficient quantity to supply local needs; the Turkish inhabitants are not fond of tilling the soil.

MOSAIC OF THE COURT WITH APERTURE FOR THE PASSAGE OF A TREE.

Assos was noted for its "flesh-eating" (*sarcophagus*) stone, which gave its name to the whole class of stone coffins found here more abundantly than anywhere else. Many of these great monolithic sarcophagi, eight feet in height and large in proportion, are described as still standing in the cemetery. All which were exposed to view were broken open long ago for the sake of the ornaments and other treasures buried with the dead. Early travelers write of seeing kids and lambs take shelter in them, and many others are used as water troughs in the neighboring villages. One hundred and twenty-four of these, however, were found unopened by the American expedition. This "flesh-eating" stone is the ordinary andesite of the hill. Of it the walls and other structures of the city were built, except that volcanic tufa was chosen for certain ornaments, gargoyles, and acroteria of the temple. The stone, being quarried in blocks by the simple process of wedging—with planes of cleavage approximately horizontal and vertical—afforded excellent material for city walls and buildings, but was too coarse-grained and intractable for use in ornamentation, and certain usual decorative features of the temple were omitted. In an early report Mr. Clarke promised to speak of the chemical properties of this stone, but he has not done so.

A good argument is made to prove that Assos stood on the site of the Homeric Pedasus, which was the early home of one of Priam's wives (Iliad, xxi, 87). Pedasus was a "lofty town on the banks of the Satnioïs," and no other lofty site is found on the banks of that river, which, though it is within a mile of the sea at Assos, does not reach the Ægean until it has had a further course of about twenty miles. In the fourth century B. C. Assos was for three years the abode of the philosopher Aristotle, who there visited his friend and connection by marriage, the "tyrant" Hermeias; and a little later it was the birthplace of Cleanthes, who succeeded Zeno as the head of the Stoic school.

The site of Assos was deserted early enough to leave the buildings and walls in fairly good condition, so that Colonel Leake, the admirable traveler and topographer, who visited it in 1800, wrote that the theater was in very perfect preservation, that remains of several temples were lying on the ground, that on the western side of the city the walls and towers with a gate were "in complete preservation," and that "the whole gives perhaps the most perfect idea of a Greek city that anywhere exists." A year later, in 1801, Dr. Hunt, who accompanied the Earl of Elgin's embassy to the Ottoman Porte, wrote of the temple on the citadel that "parts of the shafts remain on their original site, so that a person conversant with ancient architecture might easily trace the plan and different details." Neither Leake nor Hunt, however, men-

THE COURT WITH THE OCTAGONAL GARDEN AND THE CORNERS IN MOSAIC.

* Investigations at Assos: Expedition of the Archæological Institute of America. Drawings and photographs of the buildings and objects discovered during the excavations of 1881, 1882, 1883, by Joseph T. Clarke, Francis H. Bacon and Robert Koldewey. Edited with explanatory notes by Francis H. Bacon. Part I., 74 pp. Folio. Cambridge, Mass. The Archæological Institute of America. 1902.

tions marble remains, and the American explorations showed that no scrap of this stone was left above ground, and very little below. Clearly, limeburners pillaged the site with care some centuries ago. Since so much lime could not have been needed for such an insignificant settlement as seems to have existed there for a thousand years, the suggestion is not unreasonable that lime may have been exported thence as an article of commerce, although the unsubstantial modern huts, needing renewal every few years, and requiring much mortar because of the difficulty in reducing the hard stone to the exact shape desired, use a vast amount of lime.

The change in the condition of the ruins in the course of the nineteenth century was very great, and the observation of it emphasizes the truth that the archæological renaissance came in the very nick of time. Just as the irreparable loss of ancient manuscripts of the works of classical literature would have been vastly greater if the literary renaissance had been delayed for two centuries, so a like delay of archæological interest in ancient structures would have resulted in great damage. In each case the destruction seems to have become more rapid in the later centuries before the revival of interest.

After the visits of Leake and Hunt, the Turkish authorities in the first third of the nineteenth century built extensive fortifications on the citadel, probably under the influence of the Greek war for independence, in view of the proximity of the island of Lesbos and its large Greek population; and the American explorers found no stone of the temple upon another. In 1838, the reliefs of the epistyle and the metopes of the temple, so far as they lay above ground, were removed to Paris and placed in the Louvre. In 1864, the buildings and walls of the city, and particularly the theater, served as a quarry for the Turkish government, which had the largest and best blocks of stone removed to Constantinople for its public works there. The Turks even demolished the chief entrance gate of the city, an admirable monument of military architecture. The theater, which had been more perfectly preserved than any other in Asia, was "transformed into an enormous quarry," and became "little more than a hollow in the deep hillside." With this procedure may be compared the action of another Turkish official, who, during the excavations on the site of ancient Troy, sent a squad of men to Dr. Dörpfeld with a requisition for the finest blocks of stone uncovered in the course of his work.

In June, 1879, the site of Assos was visited by J. Thacher Clarke and Francis H. Bacon, young architects of Boston, and chiefly on their recommendation it was selected as its first field of explorations in classical archæology by the recently established Archæological Institute of America. Although the sculptures which remained on the surface of the ground had been carried to Paris, the earth had not been overturned either by authorized excavators or by peasants in search of plunder. The work of surveying was begun in April, 1881, and that of excavation, after many delays in obtaining the promised necessary *irade* from the Turkish government, in August of the same year. The number of laborers employed, some of whom had been trained by Humann in the excavations at Pergamon, was about thirty-five, and the work continued until the termination of the permit in May, 1883, interrupted not by the heat of summer, as in Olympia, but by the inclemency of the winters. The work was so completed as to win praise from those who have seen it. Of the portable objects uncovered, two-thirds were taken by the Turkish government, and the other third was given by the Institute to the Boston Museum of Fine Arts, the cost of the expedition having been borne chiefly by those who were interested in that museum. The explorers declared their satisfaction with the division, and when we remember that theirs was the last expedition to be allowed a share in such discoveries in Turkish lands, we may be grateful that so valuable archæological monuments came to America.

The preliminary report of the American explorations at Assos was published promptly in 1882, as the first volume of Papers of the Archæological Institute, Classical Series. Brief summaries of the investigations in the second and third years were presented in the annual reports of the Institute, but the fuller account was delayed. Mr. Clarke became so engaged in other work that he was unable to prepare such a complete and scientific statement as he desired to make. A portion of his final report was published in 1898 as the second volume of the Papers of the Institute, Classical Series, devoted chiefly to the architecture and sculpture of the temple on the acropolis, giving much attention to the elucidation of the processes of construction, and considerable space to a discussion of the date of the erection of the temple. The completion of this final report is now not considered probable, and the Council of the Institute wisely determined to publish the plans, which had been made with great skill and care, with brief explanatory notes by Mr. Bacon, and an introduction made up from Mr. Clarke's reports. This publication is the more important, since that by Texier, in 1849, of the French explorations at Assos in 1835 has been shown to be extremely inaccurate, and covered only part of the ground.

The "Investigations at Assos" is to be published in five parts, of which the first is before us, containing Kiepert's excellent map of northwestern Asia Minor, sixteen pages of text, including seven plates; seven pages of inscriptions, with their elucidations by Prof. Sterrett of Cornell University; seven pages of photographs, and twenty-one plans—all relating to the Agora, the Stoa, and the Bouleuterion. Some of these plans, naturally, are of interest only to architects and archæologists, but not a few are of more general interest. For example, Mr. Bacon's plan of the Agora, showing the relative positions of the public buildings—the Bouleuterion or Hall of Deliberation, the Gymnasium, the baths, the Stoa, the theater, and the like—and marking the paved streets, gives a more lively view than might have been anticipated of the public life of the city; and his restoration of the Agora is full of spirit. The Stoa, where the men gathered in a social way, protected from rain or from sun, stood on the slope of the hill, and had two stories, which made it unusual if not unique. The illustration of the ancient processes of architectural construction is interesting, also. Most of the plans in this part of the publication were drawn by Mr. Robert Koldewey, a Prussian architect and archæologist, at present in charge of the Babylonian excavations of the German Oriental Society, and who was at first a volunteer and then a regular member of the exploring expedition, and to whom the Agora and the buildings about it were assigned in the division of the work. We regret that, from lack of the archæological discussions which Mr. Clarke was best qualified to give, the investigations at Assos will not throw so much light on ancient Greek public life as was at one time anticipated, but these photographs and plans do more than they could fairly be expected to do in presenting a view of the ancient city.—New York Evening Post.

AN ACCOUNT OF BRONZE CASTING IN EGYPT, EUROPE AND JAPAN.*

By RANDOLPH I. GEARE.

ALMOST all the nations of the Old World have practised the art of casting in bronze from early times, although the actual date of commencement will probably never be known.

In Asia the origin of bronze casting is shrouded in extreme antiquity.

In different parts of Europe, long before historic times, weapons of defense and implements of the chase were made of bronze, and as the wants and fancies of man increased, so did the field covered by the realm of art and art-industries correspondingly develop.

In Japan the art of the bronze founder is of much more recent date, and no metal castings of any kind have been found there even approaching in antiquity those of the early bronze age in Europe.

I. BRONZE IN EGYPT.

Although it is generally admitted that bronze was employed in Egypt from the earliest days of the ancient empire, that is to say about six thousand years ago, the actual time when the art of casting in bronze was first practised there is still a matter of much speculation. Chaldea has furnished bronze figures that seem to belong to a period certainly not less ancient than two thousand years before Christ. Although of very crude workmanship, they are believed to indicate beyond all doubt that the art had been followed for many centuries previously. Bronze was here, as in other countries, gradually replaced by iron, and in Egypt the use of the latter had become more or less general, certainly as early as the second millennium before the Christian era. Therefore it seems safe to say that the greater part of the time embracing Egyptian civilization should be considered as an age of bronze. There has been much argument as to just when the iron age became established in Egypt. It is claimed by some that this took place several thousand years before Christ, in proof of which it is cited that at that remote period there had already been erected massive edifices of wrought stone, and that the stone was so hard that it could have been cut only with implements of iron or steel. Counter arguments seek to prove that metal instruments of no kind were really necessary to carve stone as hard as that used in these old Egyptian edifices, and that stone implements would have sufficed for the work, although their use would of course have necessitated slow progress. On this point Wilkinson in his work on the "Manners and Customs of the Ancient Egyptians" states that this ancient race was probably familiar with the use of emery, which was to be found in certain adjacent islands, and, if this be granted, it is easy to understand the perfection and admirable delicacy of the hieroglyphics upon the monuments of granite and basalt. "We then also comprehend," he adds, "why implements of bronze will be preferred to those of steel, which are harder and denser; for it is evident that emery powder will be incrusted upon the former, and that its action on stone becomes greater in proportion to the quantity fixed on the sharp edge of the chisel; in our times, with the same view, we prefer soft iron tools to those of hard steel." Wherefore, if his deductions are correct, the erection of those massive stone buildings could have been accomplished just as well with bronze or stone tools as with implements of iron, although the work would not have progressed so rapidly. This theory is corroborated, too, by Agatharchides, a Grecian author, who lived about a century before Christ, and who relates that in his time bronze tools had been found in the gold mines in Egypt, and he further states that iron was *entirely unknown* at the time when the first operations in mining were begun. Again, there have been found on the monuments of the ancient empire representations of men carving stone with chisels, whose yellow or reddish-brown color indicates that they were made of bronze. This matter of color has been closely examined by Montélius, another authority on ancient Egypt, who affirms that among the mural paintings, so numerous and so admirably preserved, there were a great many arms and modeled instruments, the greater part red or yellow, the rest blue. "Surely," he adds, "one will not deny that the red and the yellow represent copper and bronze, and the blue, iron or steel."

In this connection it is significant that, after the new empire had been established, metallic objects were painted blue, indicating that the use of iron tools had then become common.

It may be accepted therefore that for several centuries before Christ, bronze alone was employed for manufacturing arms and instruments, and its use was apparently confined at that time to those purposes.

And once more: objects of iron have not been found among the ancient mortuary accessories in the tombs, while bronzes have been discovered there in abundance.

From the foregoing statements it seemingly follows (1) that the Egyptians during the whole time of the ancient empire, and probably until almost fifteen centuries before Christ, were not acquainted with the use of iron, (2) that the age of bronze continued in Egypt at least until that epoch, and (3) that for centuries bronze was not wholly replaced by iron for the construction of arms and edged instruments.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

One of the most remarkable discoveries of bronze arms in Egypt was made in 1860, when some Arabs exhumed from the sand the coffin of Queen A'hhotep, who lived more than fifteen hundred years before Christ. In it were found a large number of precious objects of gold and silver, and arms of bronze, but no trace of iron. There were several gold bracelets, ornamented with precious stones and plates of glass, rings of gold for the legs, the handle of a fan made of wood and gold, etc. The arms consisted of "three poniards with blades of bronze and gold; two axes, one of gilded bronze, the other of silver; nine small hatchets, three of gold and six of silver; and a baton of authority, made of black wood and gold." The blade of one of the axes is of black bronze, gilded.

The Boulak Museum and others in Europe possess numerous bronzes which bear the name of Thoutmos III., a king of the eighteenth dynasty, who lived during the first half of the seventeenth century before Christ.

As a rule, according to Wilkinson, the proportion of tin in almost all Egyptian bronzes is about twelve parts in one hundred. The Egyptians perhaps imported their tin for industrial purposes from Asia, while copper was to be had in the immediate vicinity, even if not in their own country. The peninsula of Sinai possesses considerable mines, where operations began at a very remote period.

II. BRONZE IN EUROPE.

No one has discovered just how or when the casting of objects in bronze originated in Europe nor can its invention be placed to the credit of any particular person. The art certainly dates from prehistoric times, and, according to several Danish and German writers, the European bronze of prehistoric times was an indigenous industry, not of Phœnician origin, but was probably discovered in Britain. This is contrary, however, to the belief of Pliny, which was that the art was invented by Scytes, of Lydia, or by Theophrastus, the Phrygian.

From the lake-dwellings of Switzerland there have been obtained a large number of early European bronzes, and in one place a mold for a spear-head was found. It consisted of two slabs of stone, on each of which the form of a spear-head had been cut out. When placed together, the two halves formed an effective mold for casting. This is probably the earliest known example of piece-molding in Europe, and it was also used for casting bronze swords in Japan in early times.

Another kind of prehistoric mold was found, consisting of clay over a wooden pattern, which latter was apparently burnt out, leaving a cavity to receive the molten bronze. This is the first principle of the "wax process," referred to later, by which also the pattern was destroyed by fire.

The use of wooden patterns could be employed only in casting very simple forms, on account of the difficulty of *completely* destroying the pattern and afterward getting the ashes out of the cavity.

In ancient Greece, pre-eminently the cradle of European art, the casting of statues in bronze was always held in high estimation, and especially for perpetuating the memory of divinities, heroes and statesmen. As early as 700 B. C., the art of modeling the figure and casting it in bronze was practised at Samos. The largest pieces, such as that of the Colossus of Rhodes, were probably cast in sections of considerable thickness, with flanges on the inside by which they could be bolted or riveted together. Thus, they could be built up without internal framing, which would have been necessary if made of thin plates riveted together. This explains the great difficulty of executing large works in *beaten plate*, as opposed to *casting*. An unusually large example of the former, however, is found in the statue of Brunonia, in a chariot drawn by four horses, all larger than life—the work of Rietschel, of Dresden; but in this case a casting would have been too heavy for the gateway which had to support the group. On the contrary, the claim that the statue of Apollo at Rhodes was cast, seems proven by the fact that it lay in ruins for nearly nine hundred years, and was then sold to a Jew who, it is said, carried it away on nine hundred camels. Its total weight was computed at 720,000 pounds, and it is argued that sheet metal would hardly have lasted so long; and again, that it would probably have been stolen, had it not been for the size and weight of the pieces of which it was made up.

The Romans were passionately fond of sculpture, but as a people they did not gain great prominence as bronze-founders, usually preferring to employ foreign artists to execute their work for them. It is even recorded that Romulus had a bronze statue made of himself, probably by an Etruscan artist, to be placed in a chariot, also of bronze, which latter he had acquired and placed in the temple of Vulcan. Plutarch relates that one of the Tarquins dedicated a chariot to Jupiter Capitolinus, and that artists were brought from Veii, which was only a few miles from Rome, and had been a civilized city long before the days of Romulus and Remus. This bears out the statement already made, namely, that the Romans did not apply themselves conspicuously to bronze casting, but preferred to have their masterpieces performed by imported artists.

In the days of Numa, the representation of the gods by sculptors was forbidden by law, and no statue of any sort was allowed to be more than three feet high.

The colossal egotism of Nero is exemplified by his employment of a Greek artist to make a large bronze statue of himself, the cost of which is believed to have been between seventeen and eighteen million dollars! It did not last long, however, for notwithstanding its great cost, it was soon destroyed by the people of Rome, as a mark of their hatred of the man whom it represented. There is said to be still in the museum at Naples an equestrian statue of Nero in bronze (probably of Greek execution) which was discovered at Pompeii.

Another celebrated equestrian bronze is one of Marcus Aurelius, probably the work of a Roman artist. In strong contrast to the one of Nero, the latter has always been respected and carefully preserved by the Roman people.

Coeval with the downfall of Roman power came

the decline of art, and with it the making of statuary in bronze; indeed, from the fourth to the ninth century there is little, if any, record of artistic productions; while later, in the eighth century, Leo the Isaurian waged a war of extermination against all statues. The effect of this was to scatter the artists through other lands, and it was largely by this means that a knowledge of the principles of art was imported into France and Germany, and possibly into England also.

Not until the arrival of the twelfth century did art again begin to receive serious consideration, and with this revival we find the genius of the bronze founder coming to the front. It was now made conspicuous through the work of such men as Borissano, Bonanno and Jacopo, who were employed as builders, carvers, and bronze founders, and who cast bronze gates for several religious buildings in Italy and Sicily. In the thirteenth century England fell into line, and there are records of statuettes in bronze and silver by Simon, of Wells, and William, of Gloucester. William Torrell became famous through his statues of Henry III. and Eleanor of Castile, and at the close of the fourteenth century we read of Nicholas Broker and Godfrey Prest, who in 1397 erected statues of Richard II. and Anne of Bohemia on a tomb in Westminster Abbey.

As this was an especially important age from the standpoint of early English statue founding, it may be of interest to describe the methods employed in casting bronzes, as detailed by the well-known authority, Mr. George Simonds. "They are cast in one piece and are enormously thick, almost solid. A few years ago when some repairs were required to the stonework, I had an opportunity of examining the under side, which showed a shallow depression with a rough surface. It looked as if the metal had been poured into an open mold, and that some sort of core, heavily weighted, had been pressed down upon the molten metal so as to force it to rise to the exact level of the edge of the mold, or as if, while the metal was still fluid, or partially so, a portion had been scooped out.

I have been much puzzled to guess how the models for these figures were produced, and whether the wax process was employed. On the whole, I incline to the belief that the models were carved in wood, without any undercutting, and that any necessary projections were fashioned in wax and attached to the wood models. After the completion of the mold, the wax could be melted, and the wooden pattern easily withdrawn. A process on this principle was used for casting cannon and balls. I am certain that these statues were cast in one piece, and unless some modification of the wax process was used, we must conclude them to have been piece-molded, which I think most improbable."

The statues of Richard II. and Anne of Bohemia, by Broker and Prest, above mentioned, were made by a different process, according to Mr. Simonds. They were first modeled in clay, which was dried and pared down to form a core. This was then overlaid with a suitable thickness of wax, to represent the bronze statue, and was finished to whatever degree the artist thought necessary. The whole was then molded in clay and the wax burnt out (= the wax process).

In that same century (the fourteenth) Andrea Pisano, one of the most noted of Italian bronze founders, made the models of his great masterpiece—the bronze gates of the Baptistry at Florence. It is said that nine years were occupied in casting them. Among other Italian founders who became prominent during the period of the revival of art were Ghiberti, Donatello, Leonardo da Vinci, Michael Angelo, John of Bologna, Cellini, Verrochio, and others. The last mentioned was the artist who was employed by the authorities of Venice to make the celebrated bronze statue of Bartolomeo Colleone.

We now approach the close of the fifteenth century, a period in the history of European bronze casting when the art was widely diffused and well understood. In 1540 Cellini went to Paris, where he spent several years executing important works in silver and one in bronze, known as "The Nymph of Fontainebleau." On his return to Florence he modeled and cast in bronze a statue of Perseus, to be placed in the Loggia dei Lanzi. This he finished in 1548, casting it in two parts—one, the base with the body of Medusa; the other, the statue of Perseus himself. With the dawn of the seventeenth century the erection of equestrian statues came into fashion not only in Italy, but in France and other countries. Such a statue of Henri IV. was ordered of John of Bologna, but it was not finished till after his death and the assassination of the king. It was probably completed by Tacca, and was then sent to Paris and erected on the Pont Neuf. Another one, of Louis XIII., was erected in the Place Royal.

But perhaps the most important casting ever made in France, or may be in any other country, was that of the statue of Louis XIV., by Girardon. It was cast in bronze by the celebrated founder Jean Baltazan Keller, in 1699, but was unfortunately destroyed during the French Revolution. It was about twenty-one feet high, and was modeled in plaster on the site where it was to be cast, and when the modeling was completed, the entire statue, horse and rider, was piece-molded in plaster. A kiln was then built of fire-brick around the mold, and when it reached above the level of the top of the mold and had been filled in little by little, as the work went on, with broken pieces of brick, it was completely covered over with a layer of clay, in which several small chimneys were constructed. Fire was then started and kept up for nine days and nights, after which time the wax, which had begun to come away after the second day, ceased to flow. There were no less than five thousand six hundred and sixty-eight pounds of wax used for this statue, and of this amount two thousand eight hundred and five pounds were drawn out, the rest being evaporated and burnt off before the casting could be made. The heat was then increased with wood and allowed to rise for eight more days, the temperature thus acquired being maintained seven more days. Then the flues were closed, the whole of the interior of the kiln being at a full red heat, and the mold was allowed to cool for eight days, after which the kiln was removed. The mold was by this time thoroughly cooled. The next process was the "earthing up," followed by the construction of a dam to contain the metal when released from the furnace. When this was started, it was charged with 83,752 pounds of metal, consisting of old cannon, red gun-metal, brass, about two thousand pounds of fine Cornish tin, and a mass of old metal from the Arsenal. The fusion of this charge occupied forty hours. The molten mass of bronze was then allowed to glide down into the mold. The work was a complete success, and this somewhat detailed description of it has been given in view of the fact, as stated, it was the most remarkable and the largest piece of bronze casting in Europe, and perhaps in the world, of which any record is extant.

Any account of European bronzes would be very incomplete without a reference to the celebrated French artist Barye, who was born in 1796. He was a pupil of the sculptor Bosio and the painter Gros, and his numerous realistic groups of large game are familiar to every one. A few of his best pieces were a "tiger devouring a crocodile," a "lion crushing a serpent," the "lion of the Bastille column," and a "jaguar devouring a horse." The private collection of Mr. Walters in Baltimore is said to contain a fine series of this artist's bronzes, and there are also a large number of his productions in the Corcoran Art Gallery in Washington.

III. BRONZE IN JAPAN.

When the Japanese migrated to the islands they now occupy—seven or eight centuries before Christ—they found a people that knew nothing of metal-working. The use of bronze was not long delayed after their arrival, however, and progress in bronze casting extended from that time until about two hundred years before Christ, when it was to a large extent replaced by iron.

Authorities agree that the bronze age and the iron age in Japan are characterized by two distinct forms of sepulchral monuments; during the former, barrows or simple mounds of earth were used; while in the latter, the use of dolmens constructed of huge stones and chambered tumuli became prevalent.

Incidentally it may be observed that there is no evidence of a "copper age" preceding that of bronze. The age of copper was synchronous with the early iron period, and as late as the sixth or seventh century A. D., copper was more extensively used than bronze.

In the early days of the bronze age the objects made of that alloy in Japan consisted only of swords and arrow-heads. Objects for personal adornment were made of jasper, quartz, and other stones. Swords of bronze are found in the earth mounds, but never in the dolmens; while arrow-heads occur in both, and thus they serve as a connecting link between the two periods. These bronze swords, says one authority, are unquestionably the most ancient of all metal castings in Japan, and are a simple form of two-edged weapon, resembling the short sword of the ancient Greeks. In some, the blade was cast in one piece with the hilt, while in others the hilt was afterward attached to the blade. The mold, which was of stone, was in two pieces, but such molds are no longer used in the casting of bronze. Later, molds of clay were introduced, probably by the Chinese. Casting in molds of sand was also accomplished at an early date, and as late as the beginning of the eighth century after Christ such molds were used in the mint for the production of bronze coins. The technics of bronze founding in Japan are, however, so complex that it is impossible to go into the matter here in detail, and its consideration will therefore be treated separately at some future time.

As may be expected from a previous statement, there is a marked scarcity of castings in bronze among the objects found in dolmens and chambered tumuli. Mirrors, small bells, and arrow-heads of bronze have been occasionally found, but the large majority of objects are of iron, including swords, arrow and spear heads, horse trappings, etc. Many of them are plated with thin sheets of copper, and are usually coated with gold, and sometimes with silver.

That China and Korea exerted a powerful influence on all Japanese art, including bronze founding, cannot be questioned, and remoter countries than they doubtless helped in its development. Thus, in one temple have been found Indian statues, in bronze, of Buddhist saints and deities. Indeed, it was Buddhism (which was introduced into Japan about 552 A. D.) that had the strongest influence of all in the development of her arts and culture; so much so that the seventh and eighth centuries formed a brilliant period in the history of the art of bronze founding as well as in painting and sculpture. The explanation of this is found in the fact that numerous temples had been erected for the services of the new religion, and the skill of both native and foreign workers in bronze was enlisted for their decoration, as well as for the production of statues of the divinities of Buddhism and of vessels for the ritual accompanying the ceremonies.

But this impetus, although it lasted through two centuries, was only temporary, and when the court was removed from Nara to Kioto in 794 A. D., where it remained until thirty-five years ago, a severe blow was dealt to the art life of the former capital; nor was the new metropolis able to sustain the prominence which the bronze founders had gained elsewhere in earlier years. For nearly four hundred years there was a decided stagnation in all the arts; and yet, strange to say, during this interval, literature flourished.

In the natural course of events this decadence of art was followed by a revival which came during the latter years of the twelfth century, when peace had been established by the victories of Yoritomo. He later devoted his energies to arousing the artistic spirit of the people—which had merely lain dormant—and the next hundred years was a notable period of renaissance in art of all kinds.

The most remarkable casting of that century was a colossal image of Amitâbha, which is regarded as the greatest masterpiece in the entire history of Japanese bronze founding. It was executed about the middle of the thirteenth century by Goroyemon, and was cast in segments, which were burned together with a bronze composition, the exterior of the joints being finished with the chisel.

With the exception of two short intervals there was another decadence of art during the fourteenth and fifteenth centuries, owing to an irrepressible spirit of unrest and internal strife.

Toward the end of the sixteenth century art found another patron in Hideyoshi, who had been famous as a warrior in the wars with Korea. He erected a large wooden image of Buddha in Kioto, which was destroyed by an earthquake. He then attempted to replace it by one made of bronze, but his death in 1598 prevented him from completing it, and it was finished several years later by his son and widow.

The seventeenth century brought into prominence Tokugawa Iyeyasu, a man of remarkable ability as a warrior and statesman. He gave absolute peace to the country for two hundred and fifty years, which resulted in a development of the arts such as had never before been equaled. Indeed, it is said that Japan owes the prominent position she now occupies in the realm of art, to the works produced during this period.

Two of the most conspicuous pieces of bronze casting of the seventeenth century were a colossal figure of the Buddhist divinity Rochana, and a huge bell for the temple. The figure is said to have been fifty-eight and a half feet high, while the bell was about fourteen feet in height and nine feet in external diameter at the mouth, with a thickness of ten and three-quarter inches at the rim.

And here it may be said that the gentle rising and falling tones of Japanese bells are due to their rims being thickened internally, so that their mouths are constricted. These bells were not swung, nor were they furnished with tongues, but were rung by striking the outside by means of a beam of wood suspended from the bell tower, and caused to swing to and fro.

Many bronzes were at this time cast for the mortuary chapels and tombs of the early Shôguns and their families. At one of the mausoleums in Nikko is the tomb of Iyeyasu, a fine casting in bronze, with bronze gates. In front of the tomb are the three ceremonial ornaments of the Buddhist altar; namely, a vase, an incense burner, and a candle-stick. The surface of the gates of the tomb is regarded as a pre-eminently fine example of bronze founding, being covered with delicate diaper and floral patterns, upon which ground the bolder ornamentation is molded in relief.

Along the courtyards of these shrines are a number of large bronze lanterns, placed there in honor of the departed, or as votive offerings to the temples. The approaches and grounds of one temple alone are adorned with more than two hundred of them, presented by the territorial nobility.

About the middle of the eighteenth century a new motive appeared for making bronzes. Hitherto, they had largely taken the form of temple images and accessories, a necessary accompaniment of the religious services, but now through the long continuation of peace, art found a wider range in the designing of objects for other purposes, such as the ornamentation of the house and the needs of every-day life. Therefore from that date to the present the Japanese bronze founders have largely devoted their skill to fabricating ornaments for household use, many of which are masterpieces of form and ornament. Studies of natural objects in plant and animal life came into vogue, and quite a new impulse was given to the art.

Among the most notable men of these later times may be especially mentioned Seimen and Toün. Specimens of their work are seen in the group of tortoises (by Seimen), and the brazier (by Toün). An excellent specimen of the human figure in bronze is that of Ban-Kurobé, in the dress of a pilgrim, which was cast by Murata Kunihisa in 1783, and is now in the famous Cernuschi collection in Paris.

Following this period of brilliancy there came another era of deterioration about the end of the first half of the nineteenth century, from which critics say the art is just beginning to emerge. This deterioration is shown in the character of the bronzes made, and not, as in former times, by an almost total cessation of bronze founding. Objects often meretricious and tawdry have been produced in quantities, and (to the shame of enlightened civilization, if the charge is true) it is stated that this degradation of the art became a necessity in order to cater to the foreign demand.

ACTION OF LIGHT ON PRECIOUS STONES.*

M. MASCART called my attention some years ago to certain effects produced on the diamond by the action of violet light, projected from an arc lamp.

Impressed with the practical consequences that might result for the jewelry interest, I have pursued the investigation for the last six years.

As is known, a fluorescence is produced in the diamond by violet light. I have ascertained the existence of an intimate relation between this property and the nature of the brilliancy manifested by the diamond in artificial light, especially in candle light, which enhances the appearance of the best stones.

The diamonds which project the most vivid fires are not always those whose cutting is the most regular, but those which, examined in violet light, appear the most fluorescent. While the diamonds not fluorescent struck by this light are simply colored violet, the most brilliant stones assume a notable fluorescence of a very luminous clear blue. This diagnosis is the more valuable on account of its easy application, as diamonds, whatever their quality, offer the same transparency to the X rays.

I have observed a very curious fact with a yellow diamond of numerous facets, which presented, in daylight as in artificial light, golden reflections remarkably characteristic. The action of violet light excited no fluorescence in it, but produced at certain spots fires of a vivid red, especially noticeable on the edges cut slopingly. After application of this light, which lasted but a few minutes, I noticed with surprise that the color of the diamond had passed from yellow to deep brown, the stone losing in consequence of this change four-fifths of its commercial value. Fortunately, at the end of twenty-four hours it had recovered its original color and brilliancy.

* From the French of M. Chaumet. Paper presented to the Académie des Sciences.

This fact, the first of the kind I ever observed, appears worthy of mention, and I propose to continue my investigations in this direction.

Another fact of great practical import results from my observations on the ruby.

It is known that the commercial value of the Burma ruby is much greater than that of Siam, but these two varieties present in their exterior physical characteristics only slight differences; and if the best experts are not mistaken, it has been impossible so far to give to these differences a precise definition. Radiography does not assist. Now, in experimenting on the action of different radiations on the ruby, I have ascertained that all the Siam rubies allow violet rays to pass, manifesting but slight fluorescence, while those of Burma, all quite fluorescent, are illuminated with a bright red, which clearly distinguishes them when mixed with those proceeding from other sources, which remain darker.

These results, outside of their practical importance, raise questions of scientific interest, to which it appears to me desirable to call the attention of physicists.

OPALINE.

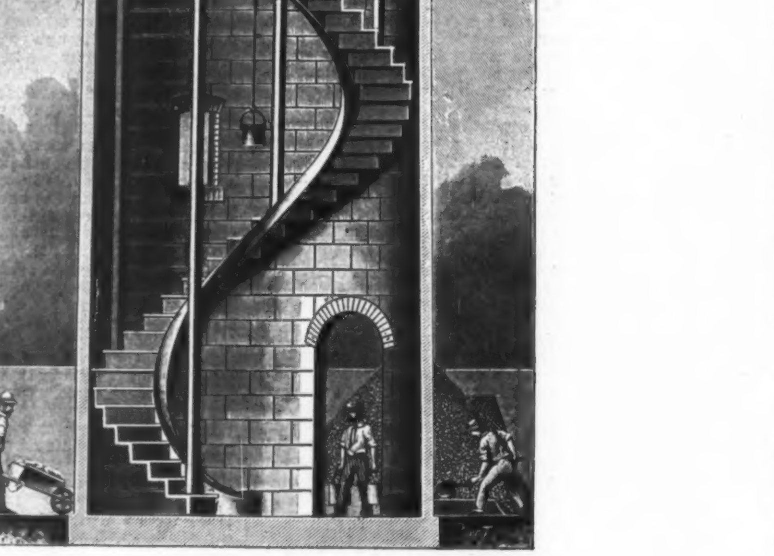
"OPALINE," a material now largely used in France for the facing of walls, is the specialty of a French house known as La Manufacture des Glaces et Produits Chimiques de Saint-Gobain, Chauny et Cirey. The material, which is employed chiefly in the form of slabs, has the appearance, in a laminated state, of a vitrified substance of a slightly bluish white shade, and is, in fact, merely a coarse glass rendered opaque by the addition of a certain proportion of fluoride of calcium. The manufacturers dwell upon the fact that no metallic oxide enters into its composition, and that it offers exceptional qualities of resistance to wear and chemican action—a peculiarity that renders it eminently suitable for hygienic applications. Such resistance, moreover, will be highly appreciated in constructions at the seaside, where the salt air and inclement weather work great havoc. Of extreme hardness and inattackable by acids, opaline possesses an insulating power identical with that of glass, and, under such circumstances, is capable of being advantageously substituted for marble for the tablets of electrical installations, since it is sold normally in the form of large sized slabs which have a surface that is absolutely smooth and easily kept clean. It is unnecessary to say that it is incapable of absorbing any liquid or of becoming spotted, as is the case with marble.

It may be used as a substitute (if not for porcelain, which is now manufactured in slabs of good quality) for at least all enameled products the surface of which easily crackles, and which are particularly affected by frost, the attack of which has no effect upon opaline. This product has arrived just at a time when people are beginning to understand that, from a hygienic standpoint, especially in hospitals, it is of the highest importance that walls shall possess a smooth and impermeable surface that may be thoroughly washed whenever it is necessary.

Opaline is used also for the internal facing of lighthouses, and has been applied to those of Ailly, near Dieppe, Cauche, and Virgin Island. In all of these it has even been substituted for a coating of cement, which was constantly deteriorating. The material has been employed for facing the operating rooms of the Bretonneau Hospital, and also the walls of the subterranean passage of the station of Bordeaux, in the former case for assuring absolute cleanliness, and in the latter for rendering the corridors particularly luminous. A host of schools at Paris, and a large number of curative establishments have their walls faced with large slabs of this material, into which it is impossible for germs to penetrate. The use of opaline (the only drawback to which is its high price) is multiplying so much the more in that, owing to its vitreous nature, it can be molded into the most diverse forms for the most varied purposes, such as copings, flutings, astragals and tiles. It can be rendered convex without any difficulty. Its ordinary thickness is from 4-10 to ½ an inch, but it is furnished also in thicknesses of from only 2-10 up to 1½ inches, while its dimensions may reach 20 square feet. The lower surface is made rough so as to facilitate the adhesion of the slab to the mortar when it is put in place.

This leads us naturally to speak of the manner in which opaline facings are formed and in this connection we are able to place before our readers' eyes a special scaffolding devised by an engineer of the Saint-Gobain Company for the opaline facing of the interior of the immense tower of the lighthouse of Virgin Island, and which may be employed for all analogous works. As long as they are but 5 feet square, the slabs are laid in cement. The rough lower surface is cleaned and freed from greasy matter and then wet and coated with a trowel with a layer of mortar from 2-10 to 4-10 of an inch in thickness. The mortar should be composed of first quality, slow-setting cement and coarse-grained sand as silicious as possible. Slabs of greater area are simply affixed to the walls by means of cramp irons or moldings of wood, metal or earthen ware, and in order to prevent movements of the masonry the edges of the slabs are made to rest upon strips of wood. In order to lay such slabs upon the entire internal surface of the lighthouse just mentioned, the flying and revolving scaffold represented herewith was employed. It consisted of a floor formed of joists and boards of sufficient dimensions to occupy the whole space of the tower, but provided with an opening for the passage of the staircase. There was also a central opening provided with a trap through which the materials necessary for the work were hoisted. This floor was firmly secured to the central pulley that permitted of raising it; but, in order to prevent any accident and any swinging of the platform while the laborers were at work, the floor rested upon certain steps through four wooden uprights of different length. The floor was thus absolutely fixed and perfectly secure. When it was desired to raise it in order to lay an upper row of slabs, the pulley served to ease it somewhat, but the lifting was really done by four workmen who stood at the four uprights and lifted these all together in ascending the same number of steps of the stairway. It was like a sort of screw that moved in a nut, and when the desired height had been reached it sufficed to allow it to rest anew upon the steps.

In conclusion, we may state that opaline can very easily be bored with a triangular drill moistened with spirit of turpentine, and may be very richly decorated with enamels and vitrifiable colors.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.



SCAFFOLDING FOR THE LAYING OF AN OPALINE FACING.

SMOKELESS POWDERS: THEIR HISTORY AND PRESENT CLASSIFICATION.

ALTHOUGH the manufacture of smokeless powder has lately made enormous progress, the subject is yet in the experimental stage. Both chemists and practical workers must still make great efforts to obtain the best possible results. The fact is not to be ignored that the powder mills of the United States produce daily from 12,000 to 18,000 pounds of smokeless powder, whose quality has been acknowledged satisfactory by the Army and Navy Departments. Certainly excellent results have been attained, but does this powder satisfy all the conditions resulting from prolonged storage and climatic changes? All that can be affirmed at present is, that there is no proof for a negative answer.

Although the history of smokeless powder is doubtless familiar to the majority of chemists, it may nevertheless be useful to briefly recall different stages it has passed through before attaining its present development.

In 1832 Braconnot discovered while treating starch, woody fiber, and similar substances with concentrated nitric acid, that a very combustible body could be obtained, to which he gave the name of xylidine. These experiments were taken up and completed by Pelouze in 1838, and this savant likewise had recourse to paper as original material. Somewhat later, Dumas prepared by means of paper a substance that he named nitramidine and suggested that it be used for the manufacture of cartridges. But this substance was found uncertain and not very useful and the researches had no practical result, when Schönbein, in 1845, announced the discovery of gun-cotton. In 1846 Boettger likewise stated that he had produced gun-cotton. Consequently these two inventors entered into partnership after having ascertained that their processes were identical. At about the end of 1846, Otto described a process for the manufacture of gun-cotton, and in 1874 W. Knop in Germany and Taylor in England discovered that gun-cotton could be prepared from a mixture of nitric and sulphuric acids.

Then numerous experiments were made in different countries for the purpose of replacing ordinary powder with this new explosive. But it was very soon discovered that this was impossible. Frightful and inexplicable explosions occurred frequently, and this caused the general abandonment of the attempt. Nevertheless, in Austria, Baron von Lenke persisted, and in 1862 patented his processes in England. In 1865, Abel also took out a patent for an improvement, consisting essentially in reducing gun-cotton to the form of a paste, which allowed the elimination of every trace of acid and rendered it more stable.

The grinding and cutting up of the cellulose fiber in specially adapted apparatus, allowed the expulsion of free acid that it had retained by capillarity, and thus one cause of its instability was removed. This process, in use at the present time, has rendered possible the employment, more and more extended, of gun-cotton.

Nitro-glycerine was discovered by Sobrero, who, by the advice of Pelouze, had undertaken the study of the action of nitric acid on glycerine. Nevertheless, to Alfred Nobel belongs the honor of opening the way for the actual evolution of smokeless powder. After discovering explosive gelatine, he ascertained that, by means of a suitable solution, nitro-glycerine and gun-cotton could be mixed in varying proportions. He thus obtained a hard horny substance, which could be granulated and employed with perfect security, as propelling power in cannon, a substance to which he gave the name ballistite.

The more recent history of smokeless powder dates from 1886, when Vielle prepared in France the B powder. The powder of Captain Schultz made its appearance about the same time. In 1882 Reid & Johnson had tested in England the powder C. E., which has been adopted for the artillery. The ballistite of Nobel was patented in 1888. Since that time numerous compositions have been proposed, of which, nevertheless, the majority have not been attended with the good results expected.

The term gun-cotton employed above to designate all the varieties of nitrated cellulose is not quite exact, since by this term is generally designated the most highly nitrated cellulose insoluble in alcohol-ether. Consequently the term nitro-cellulose will be employed as corresponding better with the facts and designating both the soluble and insoluble varieties.

The smokeless powders known at the present time can be assigned to three classes.

CLASS I.

The powders composed of nitro-cellulose, either with or without the addition of salts, capable of being freed from oxygen or inert organic substances.

This class comprises several sub-divisions, according to the degree of nitration and of the solubility of the nitro-cellulose.

(a) Powder composed of gun-cotton (fulmi-cotton) trinitro-cellulose with 14.14 per cent of nitrogen, although in manufacture the proportion seldom exceeds 13.35 per cent. This powder is insoluble in a mixture of two parts of ether and one part of absolute alcohol and only contains a very small proportion, generally less than one per cent of soluble nitro-cellulose.

(b) Powders composed of a mixture of insoluble nitro-cellulose and of soluble nitro-cellulose.

(c) Powders composed of soluble nitro-cellulose. These three sub-divisions can be varied infinitely by the addition of salts able to liberate free oxygen (commonly the alkaline nitrates), or inert organic matters (camphor, coloring substances, vegetable oils, mineral hydrocarbides, and others).

CLASS II.

Powders containing nitro-glycerine in combination with nitro-cellulose.

This class may likewise be divided into subdivisions according to the kind of nitro-cellulose employed and the presence or absence of oxygenized salts and of inert substances.

CLASS III.

Powders into whose composition enters picric acid, the picrates, or the nitro substituted products of the aromatic hydrocarbons in combination with one or several of the substances enumerated in classes I. and II.

Smokeless powders ought also to be differentiated according to their physical properties; that is, a distinction should be made between the powders called "bulk-loading" and those called "compact." The first have a low specific gravity and are manufactured in such a manner that they can be changed, charge for charge, like black powder; in other terms, that the same measure which serves for the black powder can be utilized to measure an equal volume of this class of smokeless powder, capable of producing volume for volume almost the same velocity and the same pressure. These powders are almost exclusively employed for artillery, and seldom for fowling-pieces, with lead projectiles; that is, in cases where it is only desirable that the speed should be superior to that which a regular charge of black powder produces. The "compact"

powders, on the contrary, have a high specific gravity and are used from a preference in weight, provided the volume occupied by a full charge is only from a third to a half of the volume occupied by an equivalent charge of black powder. The smokeless powders for cannon are the compact powders whose specific gravity varying between 1.58 and 1.67 approaches that of black powder.

All these productions have their merits and their defects, and the ideal composition is yet to be found.

The manufacture of smokeless powder is quite a delicate operation, and to obtain satisfactory results certain indispensable conditions must be observed, of which the chief are enumerated below.

1. The powder must be chemically stable, and when submitted to a storage more or less prolonged ought to show no sign of decomposition or of disorganization.

2. Exposed to the action of humidity, of heat, of cold, and climatic variations, it should undergo no change.

3. It should not be too sensitive to shock or friction.

4. It ought to be easy to manipulate and to be transported without danger.

5. Its gases arising from combustion should not have a disagreeable odor, nor have an injurious effect on the system.

6. It should be easily formed into grains of all sizes, and the shape of these should only be modified within very narrow limits.

7. It ought to be perfectly homogeneous.

8. It ought to possess the greatest possible ballistic power; it ought in other words to communicate to the projectile the greatest speed while giving the least possible pressure in the cannon.

Nitro-cellulose, soluble or insoluble, apparently lends itself better to the preparation of a smokeless powder, satisfying all the conditions. This substance enters into the composition of almost all the smokeless powders at present known, and the ballistic results obtained are very satisfactory, whether the nitro-cellulose is mixed with other substances, or employed in the form of a simple colloid of nitro-cellulose. The nitro-cellulose, in combination with nitro-glycerine, likewise gives very good results. This combination constitutes the English cordite, composed of 58 per cent nitro-glycerine, of 37 per cent trinitro-cellulose and of 5 per cent of vaseline.

But on the other hand, a certain number of compositions containing nitro-glycerine, in relatively slight proportions, in combination with nitro-cellulose, soluble or insoluble, have not given good results, and it is still unknown whether this is due to the composition or to the granulation, or to both.

Nitro-glycerine, constituting a chemically stable combination, seems to be best adapted to the preparation of smokeless powder. The action of nitric acid on glycerine

$$C_3H_5O_3H_3 + 3\,HNO_3 = C_3H_5O_3\,(NO_2)_3 + 3\,H_2O$$

produces a compound which, purified by repeated washings, is homogeneous and stable.

Nitro-cellulose, although perfectly stable, cannot be considered as a chemically definite compound. It consists of a mixture of nitro-celluloses in different degrees of nitration. As regards the structure of the cellulosic fiber, it has been impossible to obtain the theoretical results, by nitrating with a mixture of nitric and sulphuric acids.

The product designated trinitro-cellulose

$$C_6H_{10}O_5 + 3\,HNO_3 = C_6H_7O_5\,(NO_2)_3 + 3\,H_2O$$

exhibits in the nitrometer 14.14 per cent of nitrogen, while practically only 13.35 to 13.65 per cent is obtained. The difference is due to the presence of cellulose not transformed, and perhaps also to the presence of very small quantities of lower nitrates. The soluble nitro-celluloses, whose employment is so extensive in the manufacture of smokeless powders, consist undoubtedly of a mixture of nitro-celluloses of different degrees of nitration, and for this reason, they do not seem to be as suitable as a definite and homogeneous chemical combination.

Another disadvantage attending the employment of nitro-cellulose is due to its high price, which is much greater than that of nitro-glycerine.

It is interesting to note that Eder has prepared a nitro-cellulose soluble in etherized alcohol, which he calls penta-nitro-cellulose.

$C_{12}H_{15}O_5(ONO_2)_5 = 12.75$ per cent of nitrogen and which seems to be the most soluble of all known nitro-celluloses. Nevertheless M. Aspinall has quite recently prepared a soluble nitro-cellulose, showing 12.91 per cent of nitrogen by the nitrometer.—Translated from the Moniteur Scientifique for the SCIENTIFIC AMERICAN SUPPLEMENT.

MOUNT BEACON INCLINE RAILWAY.

ONE of the most remarkable mountain railways in this section of the country was recently built up the steep face of the North Beacon, one of the Fishkill mountains, near Matteawan, N. Y., for the Mount Beacon Association, a syndicate formed to establish a popular mountain resort on the top of the North Beacon, around which, close to its summit, a five-mile trolley line is later to be built. This mountain, as well as the surrounding country, is rich in historic interest, while views of unsurpassed beauty lend a wonderful enchantment to the place. Mount Beacon is reached by the boats of the Central Hudson Steamboat Company, leaving New York daily from the foot of Franklin Street, and the Recreation Pier at the foot of West 124th Street, stopping at Fishkill Landing, from which there is a trolley line to the base of the mountain.

Apart from historic and scenic attractions, much attention is given by excursionists to the operation and constructive features of the new incline railway, a brief description of which is herewith presented. As indicated by the accompanying illustration, the railway is a single-track road, with a turnout halfway up the mountain. It is 2,200 feet in length, with a maximum grade of 64 per cent covering about 800 feet of this distance. It is constructed of heavy yellow pine timber, including ties, securely bolted together and thoroughly ballasted with rock, with heavy guard rails of yellow pine on either side. The equipment of the power house at the top of the mountain consists of two 75 horse power electric motors geared directly to the cable-driving machinery and receiving current from the station of the Citizens' Railway Company, a mile away. There are two cars, each about 30 feet long, having a seating capacity of 60 persons. The seats are set at such an angle as to be level when the car is on the steepest portion of the incline. The cars are rigidly attached, one at either end, to a 1⅝-inch steel cable, which is wound around an 8-foot idler in the power house before passing around the 8-foot driving-drum, which is in line with but 12 feet to the rear of the idler. The length of the cable is a trifle greater than that of the railway to permit of its being wound around the drums above mentioned. It weighs about three tons, and in order to overcome the variable load which would be due ordinarily to the weight of the moving cable a variable grade was adopted, that at the top being steeper than at the bottom. The upper car exerting a greater pull on the cables than the lower one, theoretically the grades were made such that the excess of pull of one car over that of the other is just sufficient to balance the weight of a piece of cable equal in length to the distance between the cars.

In order that the wheels of the cars may pass over the cable at the ends of the turnout the wheel at one end of the axle has a wide flat face, while the other has a double flange, straddling the rail and serving as a traction guide. Besides this feature of construction emergency traction guides are provided in the shape of heavy steel projections from the car truck which straddle closely but do not touch the yellow pine guard rail on either side of the track, making derailment practically impossible.

Every possible precaution has been taken to make the railway absolutely safe, the starting of the cars being under the sole control of an attendant at the power house and governed by bell signals and telephone communication between the station at the base and the power house at the top of the mountain. A triple grip safety appliance operated by a centrifugal governor attached to the rear wheel axle is provided on each car, and should the car descend at a rate of speed above the normal the governor weights would trip the safety, thereby setting the safety knives into the yellow pine guard rail, gradually stopping the car. In case of necessity the conductor may operate the safety through a hand trip connection.

Still further protection against accident is secured by a system of magnetic control which makes the operation of the railway safely automatic, so that neither injury to the power house attendant nor neglect on his part nor failure of any part of the machinery would dangerously affect the working of the road. This result is accomplished in part by passing the electric current through what is termed an underload and overload circuit breaker, which opens the circuit in case of an overload on the cars, or, if the current drops too low to operate the machinery, it opens a circuit by which electric brakes are applied to the cable-driving machinery and the cars are brought to a standstill. Any failure of the magnetic brakes would be met by a mechanical emergency brake, controlled automatically by a centrifugal governor driven by a pulley keyed to the shaft of the idler cable drum, the excessive speed of which would set the brake and stop the cars. This emergency brake may also be operated independently by hand if necessary.

Under normal conditions the current passed through the circuit breaker starts the machinery, and on leaving the circuit breaker the current passes through a number of different circuits that control a series of magnetic accelerating switches by the operation of which the movement of the machinery is gradually accelerated, bringing the cars to full speed. This gradual movement of the cars, being automatic, is not governed by the manipulation of the controller, as in ordinary trolley car practice. The power house attendant or operator may only start or stop the cars, for as the car approaches the station it opens a number of limit switches placed on either side of the track and the circuits governing the operation of the magnetic accelerating switches above referred to are opened, gradually cutting off the current and finally bringing the car to a stop.

MOUNT BEACON INCLINE RAILWAY.

THE AGE OF THE WORLD.

SIR EDWARD FRY contributes an article to the Monthly Review upon the probable age of the inhabited world and the rate at which the various species of animals have been differentiated from their common ancestors during the lapse of time that living matter has appeared upon the earth.

At present the problem has been approached along three lines of inquiry, and no one of these three has hitherto produced results in agreement with either of the other two. The physicist, arguing from the dissipation of the earth's heat, the contraction of the sun, and the action of the tides, places the time since the consolidation of the earth as being much nearer twenty million than forty million years ago, an age sufficiently revolutionary compared with the older chronologies of the western world, but altogether insufficient, in the opinion of the geologist and the wise men of biology, to account for the thickness of the earth's strata and the highly complex subdivisions of class and species which exist among the plants and animals of the earth. Arguing from the present rate at which beds of sand, chalk, and other matter are being deposited by river or sea in different parts of the world, the geologist declares that four hundred and fifty million years must have elapsed since the commencement of life on the globe. But when we examine the biologist's estimate, the discrepancy between the three becomes much larger. Sir Edward Fry, quoting Prof. Poulton's opening address at the British Association in 1896, obtains a total of two thousand seven hundred million years as the age of the world since it was first inhabited by living organisms. This enormous span of time becomes necessary on the assumption that the variations of species have only proceeded very slowly, and that any sudden alteration in type cannot be transmitted to the descendants of the variants.

Sir Edward Fry claims that there are forms of alteration in animal life other than that of the slow step-by-step mutation to which Darwin first attracted attention. The first alternative Sir Edward adduces is that of "pelorism," a phenomenon which occurs among many plants, and seems to point to a case of sudden variation in the form of a flower. This variation is no monstrosity, since its character is readily transmissible to descendants, and it constitutes no reversion to an ancestral type, since it is a jump forward toward a form hitherto unknown in the plant's genealogy. This abnormal development was first observed over a century and a half ago in the yellow toad-flax growing on a Baltic island near Upsala, and has been lately traced by one observer in a hundred and ten varieties of plants. "The consideration of this single flower," writes Sir Edward Fry, "seems at once to

show that there are other modes by which one organization may pass into another than by the slow accumulation of small variations; that a single variation, not small, not accumulated, but sudden, may carry a race from one family to another; . . . that the new plant may be endowed with means of reproduction, and actually reproduce the new form; in a word, that the pace of organic change is not always slow, but is sometimes rapid." In a following paper Sir Edward proposes to bring forward other examples of inheritable changes in organisms due to a sudden change in environment, and also similar changes which continue to be transmissible so long as the new environment continues.

TRADE NOTES AND RECIPES.

Violet Color for Ammonia.—A purple-blue color may be given to ammonia water by adding an aqueous solution of litmus. The shade when pale enough will be a violet color.—Drug. Circ.

To Remove Petrolatum Stains from Clothing.—Moisten the spots with a mixture of 1 part of anilin oil, 1 of powdered soap and 10 of water. After allowing the cloth to lie for five or ten minutes, wash with water.—Drug. Circ.

Cement for Parchment Paper.—The editor of the National Druggist says that his experience with pasting or cementing parchment paper seems to show that about the best agent is casein cement, made by dissolving casein in a saturated aqueous solution of borax.—Drug. Circ.

Albumen as a Paste.—Fresh egg albumen is recommended as a paste for affixing labels to bottles. It is said that labels put on with this substance, and well dried at the time, will not come loose even when the bottles are put into water and left there for quite a while. Albumen, dry, is almost proof against mold or ferments. As to cost, it is but little, if any, higher than gum arabic, the white of one egg being sufficient to attach at least a hundred medium-sized labels.—Drug. Circ.

Polish for Brass.—The following is a fluid cleaner and polish:

Prepared chalk	2 parts
Water of ammonia	2 parts
Water, sufficient to make	8 parts

The ammonia saponifies the grease usually present. It must be pointed out that the alkali present makes the preparation somewhat undesirable to handle as it will affect the skin if allowed too free contact.—Drug. Circ.

Preserving the Freshness of Cut Flowers.—The usual method of preserving cut flowers in a condition of freshness is to dissolve small amounts of ammonium chloride, potassium nitrate, sodium carbonate, or camphor in the water into which the stems are inserted. The presence of one or other of these drugs keeps the flowers from losing their turgidity by stimulating the cells to action and by opposing germ growth. Flowers that have already wilted are said to quickly revive if the stems are inserted in a weak camphor water.—Drug. Circ.

Restoring Faded Writing.—Writing on old manuscripts, parchments, and old letters that has faded into nearly or complete invisibility can be restored by rubbing them over with a solution of ammonium sulphide, hydrogen sulphide, or of "liver of sulphur." On parchment the restored color is fairly permanent but on paper it does not last long. The letters, however, could be easily retraced, after such treatment, by the use of India ink and thus made permanent. Of course this treatment could not restore faded anilin ink. It only works with ink containing a metal like iron that forms a black sulphide.—Drug. Circ.

Removal of Picric Acid Stains.—According to the Apotheker Zeitung, recent stains of picric acid may be removed readily, if the stain is covered with a layer of magnesium carbonate, the carbonate moistened with a little water to form a paste, and the paste then rubbed over the spot. The stain is said to disappear in a very short time under this treatment.

Another method of removing these stains is to apply a solution of:

Boric acid	4 parts
Sodium benzoate	1 part
Water	100 parts

To Clean Straw Hats.—Sponge the straw with the following solution:

Sodium hyposulphite	10 grammes
Glycerin	5 grammes
Alcohol	10 grammes
Water	75 grammes

Lay aside in a damp place for twenty-four hours and then apply:

Citric acid	2 grammes
Alcohol	10 grammes
Water	90 grammes

Finally press the hat with an iron moderately heated. If the straw require stiffening, it should be washed with a weak gum water before ironing.—Drug. Circ.

Refinishing Gas Fixtures.—Gas fixtures which have become dirty or tarnished from use may be improved in appearance by painting with bronze paint and then, if a still better finish is required, varnishing after the paint is thoroughly dry with some light-colored varnish that will give a hard and brilliant coating.

If the bronze paint is made up with ordinary varnish it is liable to become discolored from acid which may be present in the varnish. One method proposed for obviating this is to mix the varnish with about five times its volume of spirit of turpentine, add to the mixture dried slaked lime in the proportion of about 40 grains to the pint, agitate well, repeating the agitation several times, and finally allowing the suspended matter to settle and decanting the clear liquid. The object of this is, of course, to neutralize any acid which may be present. To determine how effectively this has been done, the varnish may be chemically tested.—Drug. Circ.

ENGINEERING NOTES.

Some unusually long and heavy steel rails have been manufactured for utilization upon the railroad bridges above the streets in Lille. The rails are approximately 85 feet in length and weigh 2,297 pounds. They have been made in these lengths so as to obviate the rails having a joint upon the bridges, since joints thereon cause unnecessary noise and require extra care to maintain their efficiency and durability.

According to the American Iron and Steel Association, there are in the United States 140 bridge-building works in operation, one is in process of completion, and five others are projected. The American Bridge Company, comprising 21 works, has a capacity of 735,000 tons; the Empire Company, comprising five works, of 81,000 tons; but in separately owned works anything over 10,000 tons per annum is exceptional. There are 72 shipbuilding yards completed, four building, and three projected. The locomotive works number 34 completed, one building, and one projected. The producing capacity of the "combination" is given as 2,775 steam and electric locomotives per annum—about nine per day from their eight works. Schenectady is recorded as capable of producing 900 and Brooks 700 per annum, leaving 1,175 for the other six. There are 172 car-building works. The 14 works in the "combine" are put down as producing each year 900 passenger and 157,150 other cars. There are 109 steel pipe and tube works.

The Swiss Locomotive and Machine Company of Winterthur, have recently built a De Glehn 10-wheel 4-cylinder compound engine for service in the Simplon tunnel, which will shortly be opened. The engine has been designed to haul a train of 300 metric tons on a road having numerous curves up a grade of 1 per cent at 31 miles per hour. The total weight of this engine is 141,100 pounds, and the weight on drivers 105,800 pounds. The high-pressure cylinder measures 14 5-32 inches diameter, and the low-pressure cylinder 22 7-16 inches diameter, the stroke being 23⅝ inches. The valves are Richardson double ported, and have extended valve stems. The valves of the high-pressure cylinders are horizontal, while the low-pressure valves are slightly inclined outward. The Walschaert valve motion is used on the high-pressure cylinders, while the low-pressure cylinders have the Joy valve gear. The boiler has a straight top, and is fitted with a Belpaire firebox constructed of copper. The working pressure is 213 pounds per square inch. The heating surface is 2,670 square feet, and the grate area 29.2 square feet. The tender is of the 8-wheel type, with outside frames, and has a capacity of 4,570 gallons and four metric tons of coal.

An important canal project is to be carried out in Scotland for connecting the Firth of Forth with the River Clyde, thus giving a shorter and quicker passage from the Atlantic Ocean to the North Sea. Only a narrow neck of land separates the two waterways, and many important schemes have been suggested for effecting their junction, but none has reached fruition. The present project is to commence the canal above the new British naval base and the estuary of the Forth at Alloa. The route will be carried to Stirling through the valley of the Forth to Kippen, thence by a deep cutting into Loch Lomond, which will be employed for navigation as far as Tarbet, where another cut will be made through the narrow isthmus dividing Tarbet from Arrochar upon the banks of Loch Long. This canal will cut Scotland in two, and the waterway will be sufficiently wide and deep to admit of the passage of the largest and heaviest vessels. Not only will it afford a shorter and quicker route from America to Europe *via* the North of Ireland, but it will be of great political importance, and naval vessels will be able to communicate with the two opposite shores of the country with greater celerity and facility than is now possible. It is estimated that the construction of the canal will cost $50,000,000.

Another industry which has hitherto been considered an impregnable handicraft, has succumbed to the development of the machine. It has always been maintained that the art of the gun setter, owing to its delicacy, skill, and minute exactness, was impossible by other than manual labor. Barrel setting is an extremely delicate operation, necessitating a keen eye and cunning hand on the part of the workman. It is the occupation of a comparative few. When a barrel is bored and rifled by the machine, although to the ordinary observer it may appear perfect, it is far from being the case; but so carefully has the defect to be remedied, that it has to be accomplished by hand. The barrel setter fixes a line as a determining factor upon the shining surface of the barrel, and then closely looks through it as if it were a telescope. The defect in the barrel is immediately shown by a slight shadow thrown by the determining line, and the barrel is then placed on an anvil and gently tapped with a hammer until the shadow of the line comes down the surface of the barrel in one perfectly continuous straight line. The operation of barrel setting appears an easy task, but its main difficulty lies in the tapping, where it must be done, and the strength of the taps—an art that can only be acquired after years of practice and training. The gun setters are very jealous of their work, and it is not open to all comers. Hence in Birmingham, the center of the English gun-making industry, the gun setters have always maintained an independent attitude, and have always demanded high salaries. For years repeated attempts have been made to devise a machine which would perform the tapping task, but without success, since it is absolutely essential that the barrels of military rifles should be dead true. An inventor, however, has at last succeeded in devising a machine, which prolonged tests have proved to be in every way as efficient as manual labor in barrel setting. It is already being pressed into service for setting the barrels for the rifles for the British army. It is being sedulously guarded, so that its design and operation are unknown, and for the present it will not be utilized for setting the barrels of guns other than service rifles. The main advantage of the machine in this direction will be to expedite the manufacture of rifles to a very appreciable degree.

ELECTRICAL NOTES.

The Northeastern Railway of England is about to change a part of its system from steam power to electricity. Mr. Reaven, the Superintendent of Motive Power of the road, is now in Canada for the purpose of gathering information. He states that it is intended to use electricity around Newcastle, where 47 miles of road are somewhat congested by the dense population, and where 2,500,000 passengers are carried during the year. The cost of the change will be about $1,250,000. Each car will have its own motor, so that electric locomotives will be dispensed with. The question of utilizing electricity as a motive power has been for some time occupying the attention of several of the British railway boards, and Mr. Reaven states that he had learned, since reaching Canada, that the Lancashire and Yorkshire road had determined to change its motive power to electricity at Manchester, Liverpool, and other large centers of population. It is also announced that an American syndicate has offered to purchase the Great Western Railroad, that the negotiations are still in progress, and that if they are successful the road will be equipped throughout with electric power.

Natal in South Africa, says the London Electrician, lays claim to the possession of the first tea factory to be driven by electricity, and it is possible that the actual drying of the tea itself by the same agent will shortly be attempted. The works are situated near the River Umhloti, and obtain the electrical energy from a power house between three and four miles away. The whole question involved in the adoption of electric power for this industry was the cheapening of the cost of production, preparation, and transit, and it is promising to hear that the results so far have given every satisfaction. Water power for driving the generating machinery is obtained from the river, and the plant at present installed consists of one 100-kilowatt turbo-dynamo, which is sufficient for present needs. The dynamo develops 5,000 volts, three-phase, at 500 revolutions per minute, with a periodicity of 50. The power is transmitted at this pressure by three single-core cables carried overhead to the factory 3 1-3 miles away, and also to the several dwelling houses on the estate, including the mansion house of the head of the firm, Sir James L. Hulett, Speaker of the Natal Legislature. At the end of the transmission line the voltage is reduced by static transformers for the requisite power and lighting. In connection with the tea factory, the firm are laying down an electric railway some 24 miles long to a place called Mapunilo. It is anticipated that this line will favor the supply of labor from districts hitherto not easily accessible, and prove remunerative in the way of freight and point-to-point passenger traffic.

In depositing metal electrolytically upon a non-conducting base, it is, of course, essential that a conductive surface be afforded, and this is usually accomplished by the chemical precipitation of a thin layer of silver or other metal, or by the mechanical application of graphite or metal powders, often with the aid of an adhesive binding medium. Such coatings, and especially the highly perfect ones, formed by the chemical precipitation of silver, are of a high degree of density, and, therefore, of high electrical resistance, from which it follows that even with the low density currents used for electroplating the deposit cannot take place evenly over any extended surface. The important point, therefore, in securing a perfect cathode connection to work of this character is the number of the contacts. Mr. C. P. Townsend, in the Electrical World recently, describes a simple arrangement for electroplating lace, consisting of an open-meshed basket of copper wire, upon which the lace, suitably prepared with a conductive coating, is stretched. The contrivance is the invention of Mr. J. A. Daly, of Washington. Fine copper wire is wound in coils around the basket and over the lace in such a manner as to secure the fabric and to provide a number of contacts, which must be greater in proportion as the mesh of the lace is more open. Deposition is said to proceed evenly over the entire surface, and it is claimed that the simplicity of the manipulation effects a saving of 90 per cent of the time usually required for wiring. The deposition should proceed under these conditions for a few moments only, the object being merely to stiffen the fabric by a preliminary deposit in order that it may be hung in the bath from the usual supports to receive the final and heavier coating.

The weights of electric locomotives vary from 4,000 to 30,000 or even 40,000 pounds. A 12,000-pound machine would have about the following proportions: draw-bar pull on the level, 1,500 pounds; speed, 6 to 10 miles per hour; two 20 horse power motors; a minimum gage of from 27 to 30 inches; minimum width over all, 48 to 50 inches; minimum height of from 36 to 40 inches; length, excluding bumpers, from 9 to 12 feet; wheel base, from 40 to 55 inches; diameter of wheels, from 28 to 30 inches. A 24,000-pound locomotive would have a drawbar pull of 4,500 pounds; 6 to 10 miles speed; two motors of 50 horse power each; gage of from 35 to 40 inches; outside width of from 58 to 65 inches; height of from 38 to 45 inches; total length of from 11 to 12 feet; wheel base length, from 40 to 56 inches; and diameter of wheel from 28 to 30 inches. The minimum weight of rails that can be used satisfactorily varies from 8 pounds per yard for a two-ton locomotive to 40 pounds for the heaviest. Mines using from 12,000 to 16,000-pound machines should, under ordinary conditions, use about a 30-pound rail. Where exceptionally heavy service is encountered the adoption of 60-pound rails is meeting with favor. The drawbar pulls are given for running on the level. On an up grade the pull will be reduced on account of the locomotive having to pull up its own weight. The element of the force of gravity tending to pull the car down hill, and which therefore must be overcome, is approximately one hundredth of the total weight for each per cent grade. This would be equivalent to a drawbar pull of 20 pounds per ton. In the case of the 12,000-pound locomotive given above the drawbar pull on a 5 per cent grade would thus be reduced from 1,500 to 900 pounds.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Portland Cement in Germany.—In reply to various inquiries from the United States concerning the present condition and prospects of the Portland-cement industry in Germany, the following report is respectfully submitted:

The cement manufacture may be designated as that one of the great, long-established industries in this country in which the capacity of production is most excessive and disproportionate to the normal consumptive power of the people. There were in operation in this country at the close of 1899 261 cement factories, and their number has increased rather than diminished since that time.

During the year 1901 there was consumed in Germany 14,600,000 barrels of cement, while the reports of the several syndicates show that the collective productive capacity of all their factories for the same period was 29,000,000 barrels per annum. The power of production had thus, in respect to Portland cement, outgrown the actual home demand by 100 per cent. Just how much cement was really produced in that year is difficult to ascertain. The cement factories of Germany are divided into several syndicates, which fight each other with persistent valor and reveal as little of the inside workings of their several organizations as possible; but from all indications and estimates, there must have been in 1901 a surplus of from 10,000,000 to 12,000,000 barrels, of which there was exported 506,652 tons, leaving a large excess, which broke down the market, reduced profits to a pittance, and brought on a crisis in the industry from which it has not yet recovered.

In tracing the causes which led up to this result, it is noticeable that during the ten years from 1890 to 1900 all kinds of constructions which use cement were phenomenally active in Germany, and the consumption was enormous and steadily increasing. Millions of barrels were used in the construction of the Kaiser Wilhelm and the Ems canals and in improvements in the Rhine, Weser, and other rivers. It was expected that the Midland canal would also be authorized and the cement factories made preparations to meet that additional demand, so that the failure and postponement of the project were among the contributing causes to the overproduction of that period. The situation led to a new effort to unite the several local syndicates and groups into which the cement makers were divided into one national and all-embracing combination, which could restrict the output, shut down superfluous factories, and, by getting the industry thoroughly in hand, restore prices to a profitable basis. All such efforts proved futile, and the war between the competing factories was bitter and unrelenting.

The year 1902 brought no substantial relief. The supply of cement everywhere exceeded the demand. Building operations slackened under the general industrial and financial depression, while labor and fuel—two of the principal factors in cement production—maintained practically undiminished values since the prosperous years preceding 1900. The only outlet for the surplus was through exports, and these slowly increased from 497,780 metric tons in 1898 to 528,676 tons in 1899, 543,991 tons in 1900, and 641,520 tons in 1902. Of this large export the United States takes a larger share than any other nation, the shipments to our country aggregating 197,174 tons in 1900, 108,596 tons in 1901, and 246,726 tons in 1902. Next in order of importance in this respect comes the Netherlands, which last year took 66,837 tons of German cement; British South Africa, 36,720 tons; Great Britain, 33,534 tons; and Brazil, 18,209 tons.

Under the present tariff, cement is free of duty when imported into Germany, and there was a small influx of 51,947 tons in 1902, which came across the border at points in Belgium, Denmark, France, Austria, and Switzerland, where factories near the frontier were geographically tributary to German territory. To shut out this slight competition the new German tariff imposes a duty of 50 pfennigs (about 12 cents) per 100 kilogrammes ($1.20 per metric ton) on cement, against $4.04 per ton duty assessed by Russia, $2.38 in Austria and Switzerland, $1.42 in Sweden, and $1.76 in the United States.

The sum of all recent information is that only the oldest and largest factories in Germany, which enjoy every advantage of location for obtaining raw material and handling their product, are able under present conditions to earn any substantial profit; many of the newer and smaller establishments are working at a loss. Early in the present year there was a meeting in Berlin of cement manufacturers from all parts of the Empire, which, after a long, secret session, appointed a commission to consider and report in April upon a plan for the organization of the entire industry under a cartel, or syndicate, which should control output and manage the market. Thus far it would appear that the commission has not reported, and its continued silence is construed as an indication that the differences between local syndicates and individual factories have again been found irreconcilable, and that no general basis of combination can be reached.—Frank H. Mason, Consul-General at Berlin.

American Automobiles in Malaga.—Within the past few months an interest in automobiles of American make has been manifested in Malaga. This is due in part to the recent importation of a French machine of the racing type, which is the only automobile now in Malaga.

A few days ago one of the most influential men in this city requested me to procure for him price lists and catalogues of American automobiles, and to-day another of Malaga's representative men informed me that he had just placed an order with a Detroit firm for the purchase of a machine propelled by gasoline, and that several of his friends are awaiting the advent of the first American machine to compare it with European designs. This seems to be an excellent opportunity for American manufacturers who desire to establish a market here, as the marked advantage in prices in favor of American machines seems to be understood in Malaga. The roads about this city offer facilities for trips to near-by villages, and the outlook is that within a short time many machines will be in use here.

If American manufacturers will send their catalogues or other reading matter to this consulate, I shall take pleasure in handing them to parties interested and in placing them in the reading room of the principal club of Malaga.

Promptness of delivery is an essential point that should not be overlooked by American manufacturers sending machines to Spain. The French makers have an immense advantage in this respect.

I am informed that nowhere in Spain—certainly not in this section—is there an American automobile firm represented by an agency.—D. R. Birch, Consul at Malaga.

American Goods at the Osaka Exhibition.—Consul S. S. Lyon sends from Kobé, May 20, 1903, newspaper clipping descriptive of the foreign exhibits at Osaka, as follows:

"The exhibits in the large building just to the rear of the Canadian Building are well worth a visit. They are absolutely and entirely American and represent the agencies that Mr. F. W. Horne, of Yokohama and Tokyo, controls. Mr. Horne could only obtain a space of 7 tsubo (42 square feet) in the Foreign Samples Building, and as this would not have answered his purpose he decided to erect a building for himself. It covers 200 tsubo (1,200 square feet) and is fitted as nearly as possible as a model machine shop, with plenty of light and air, and contains over 150,000 yen ($74,700) worth of the latest American machinery, all in working order.

"The biggest exhibit is a Miles Bement Pond Company and Pratt & Whitney radial boring drill and 37-inch boring and turning machine. There are also, by the same firms, a slotting machine, a horizontal boring machine, a steam hammer, and some specimens of small tools. Many ingenious appliances are shown by the Chicago Pneumatic Tool Company. Close by is a 24-inch Gisholt lathe, which, together with two larger ones has been sold to the Mitsu Bishi Company. There are also some printing presses by Chandler & Price, lathes by Bradford & Sebastian, and a compressor made by the Rand Drill Company. A good many engineers thoroughly understand the principles of boilers, but do not know how to set them properly. Mr. Horne has placed a 50 horse power boiler in position, leaving a portion of the brickwork open, so that students and others interested may examine it and learn how to set a boiler with accuracy. We understand that many young Japanese engineers and mechanics have already taken advantage of the useful information which may be derived from a study of this somewhat novel exhibit.

"Just above this, one of the Buffalo Forge Company's disk ventilating fans has been fixed and creates a perfect passage of air on the 'down-draft forge' system. The Fay-Egan Company has on view a woodworking machine, including a No. 9 band-saw mill, a planer and matcher, a band-scroll saw, and a variety saw and hand planer. There is a full line of Laidlaw, Dunn, Gordon, and Asiatic duplex steam pumps; and lathes and planer chucks, made by the Skinner Chuck Company. On the wall is a fine case of 'instruments of precision,' by Brown & Sharpe and L. S. Starret. Some examples are shown of Messrs. W. F. & John Barnes's drills and lathes, one of which has been sold to the Fukuoka Technical School and one to Mr. Shimadzu, of Kyoto. The Unozawa Works, at Tokyo, have bought one of this firm's 22-inch drills, and the Mayejima Works, at Tokyo, are the purchasers of a 22½-inch drill. A Warner & Swazey hexicon lathe, capable of very fine work, is exhibited, together with a 16-inch monitor lathe for making valves, and Ashcroft steam gages. Brown & Sharpe have a fine display, including a 36-inch automatic gear cutter and an automatic service grinding machine. One of the most complicated and interesting machines is this firm's automatic screw machine. The steel rod is put in at one end and in twenty seconds the well-finished screw appears at the other. One of the William Sellers universal tool grinders, as used at the Kawasaki and Mitsu Bishi Yards, is also shown. Among the other exhibits are specimens of asbestos by H. W. Johns-Manville Company, Hart duplex stock dies, Curtis & Curtis type threaders, Blickensderfer typewriters, diving suits and apparatus by James Morse & Sons, William Powell steam valves, exhibits by the Norton Emery Wheel Company, the Morris Machine Company's centrifugal pumps, and a variety of other articles which can not fail to afford interest and instruction to those even remotely concerned in engineering enterprise. In the center of the room the Columbia Phonograph Company have some of their latest phonographs.

"Mr. Horne's building is very creditable. In the Foreign Samples Building he has also some exhibits, including Edward Miller lamps, Mott's sanitary goods, and Hall's safes."

Delay in Shipping Goods to Malta.—In recent reports upon American flour in Malta,* I referred to the increasing demand for that article. It must not, however, be understood that the trade is absolutely secured to us. In conferring with firms here who are interested in the importation of flour, I have discovered an evil which, if not remedied at once by American millers, will eventually result in a large dropping off in their sales. I refer to tardy shipments. Maltese buyers are complaining greatly of the delay on the part of railway companies in the United States in delivering goods at the docks in New York, on account of which they are unable to rely upon even an approximate date of arrival here. It has often happened that flour ordered to be forwarded to Malta at stated intervals has been so long delayed by transportation companies in the United States that the different consignments were received simultaneously. When it is considered that the Maltese buyer has to figure very closely in order to make even a small margin of profit and has to look ahead in order to place his goods upon arrival, it will be understood, perhaps, how inconvenient it is for him to suddenly receive two or more orders *en masse* instead of at intervals as ordered. Lack of promptness in delivery at New York docks also causes loss by reason of fluctuation in values. As a rule, the Maltese buyer has a great deal of patience, but I hardly believe it will last in this matter, and unless American millers and others interested in the trade speedily effect a change in present methods of shipping I am afraid several houses here will transfer their patronage to other countries. I have a case before me which illustrates this point: A consignment from a St. Louis house has just arrived after three months' delay. It can not be said, however, that any blame for the loss of time rests with the steamship company, as its service is very satisfactory.

This is a peculiar market and has to be handled very carefully to avoid loss. No one knows this fact better than the Maltese buyer, and when he settles his accounts satisfactorily it does seem that our sellers might assist him, at least to the extent of filling orders and delivering as directed. It must be remembered that the Maltese merchant does not order flour from the United States just for the sake of storing it up. Here, as in the United States, its sale is regulated by market opportunities.

I trust this matter will be looked into at once by parties interested.—John H. Grout, Consul at Valletta.

* See Advance Sheets Nos. 1570 and 1671.

Quay Duties at Pointe a Pitre, Guadeloupe.—Consul L. H. Aymé, of Guadeloupe, under date of June 10, 1903, says:

A decision of the Court of Cassation of France, recently made public, declares the quay duties collected at Pointe a Pitre to be illegal. These duties were imposed about forty years ago by a local regulation. In 1900 a notice in the Journal Officiel fixed the following rates:

PARCELS, WHETHER GROUPED OR NOT GROUPED.

Description.	Tax per parcel.	
	Francs.	Cents.
1 to 100 kilogrammes (2.2 to 220.4 pounds).....	0.15	2.89
101 to 200 kilogrammes (222.6 to 440.9 pounds)..	.25	4.82
201 to 300 kilogrammes (443.1 to 661.3 pounds)....	.35	6.75
301 to 400 kilogrammes (663.5 to 881.8 pounds)..	.45	8.68
401 to 500 kilogrammes (884 to 1,102.3 pounds) .	.55	10.61
501 to 600 kilogrammes (1,104.5 to 1,322.7 pounds)	.65	12.54
601 to 1,000 kilogrammes (1,324.9 to 2,204.6 pounds)	.75	14.47
Over 1,000 kilogrammes (2,204.6 pounds) for each 100 kilogrammes (220.4 pounds)...	.10	1.93
Horses.............................per head..	1.00	19.3
Asses	.50	9.65

It has now been decided that the duties were illegal, and an attempt will be made to establish new and legal rates, which, however, will be much more moderate.

The Question of Dutiable Values.—Consul-General F. H. Mason writes from Berlin, June 16, 1903:

German exporters of manufactured goods are preparing to make a united and vigorous protest against the methods of determining dutiable values which are practised by the appraisers' department of the United States Treasury. A circular has been issued to exporters throughout the Empire in which they are each invited to send to the central association—"Der Bund der Industriellen"—a statement of their grievances. The text of the circular is herewith translated as follows:

"1. Have you had difficulties in making imports into the United States by reason of the market values as fixed by the appraisers?

"2. In the determination of dutiable values, was the German or the American market price of the goods taken as the basis or standard?

"3. Were the dutiable values of your merchandise decided to be higher than you had declared them in your invoices?

"4. Have you made appeal to the Board of General Appraisers, the collector of customs, or the Secretary of the Treasury against such advances in duty value?

"5. Was the proceeding (of the appraising officers) a legal or an abitrary one?

"6. Have you been wronged or injured by the arbitrary decision of dutiable values on the part of American officials, and if so, to what extent?"

It is intended that the replies to these interrogatories shall be classified, formulated, and used as proofs to support a protest against the present system of appraisement.

Coinage for Venezuela.—Consul E. H. Plumacher writes from Maracaibo, May 26, 1903, that a legislative decree of April 11 authorizes the Executive to coin 4,000,000 bolivars ($772,000) in silver, the work to be done at the mint at Philadelphia. Two million bolivars ($386,000) are to be in coins of 5 bolivars (96.5 cents); 1,000,000 bolivars ($193,000) in coins of 2 bolivars (38.6 cents); 800,000 bolivars ($154,400) in coins of 1 bolivar (19.3 cents); 100,000 bolivars ($19,300) in coins of 50 centimes (9.6 cents); and 100,000 bolivars ($19,300) in coins of 25 centimes (4.8 cents). The circulation of this coin will be obligatory for the subjects in the proportion established for silver in the sole paragraph of article 17 of the law of July 9, 1891, on national money and under the penalty named in article 23 of the same law.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. The other Reports can be obtained by applying to the Bureau of Trade Relations, Department of Commerce and Labor, Washington, D. C. Since the number of Reports is limited, application for those which are desired should be made immediately.

SELECTED FORMULÆ.

Brown Dressing for Untanned Shoes.—

Yellow wax	300 parts
Soap	120 parts
Nankin yellow	25 parts
Oil of turpentine	1000 parts
Alcohol	120 parts
Water	1000 parts

Dissolve in the water bath the wax in the oil of turpentine; dissolve, also by the aid of heat, the soap in the water, and the Nankin yellow (or in place of that any of the yellow coal-tar colors) in the alcohol. Mix the solutions while hot, and stir constantly until cold. The preparation is smeared over the shoes in the usual way, rubbed with a brush until evenly distributed, and finally polished with an old silk or linen cloth.—Pharm. Era.

Colic Powder for Horses.—The following powder is said to have been found excellent as a powder to cure colic in horses:

Aloe	150
Chloral hydrate	25
Sodium sulphate	500
Althea root	100

Give one tablespoonful every three hours.—Pharmaceutische Zeitung.

Ordinary Negative Varnish.—

Gum sandarac	1 ounce
Orange shellac	½ ounce
Castor oil	90 minims
Methyl alcohol	1 pint

Allow to stand with occasional agitation till dissolved, and then filter.

The negative should be heated before a fire till it can be comfortably borne on the back of the hand, and then the varnish flowed over, any excess being drained off, and the negative should then be again placed near the fire to dry.—Pharm. Era.

Violet Sachet Powder.—Granulated orris, 4 ounces; sandalwood sawdust, 2 ounces; patchouli leaves, 1 ounce; lavender flowers, 1 ounce; ionone, 15 minims; musk, 1 grain; bergamot oil, 15 minims; bitter orange oil, 5 minims; otto of rose, 2 minims; coumarin, 4 grains. Mix.—Spatula.

Sweetened or Tasteless Castor Oil.—Tasteless or sweetened castor oil is prepared by thoroughly washing the oil with hot water and incorporating sufficient (¼ to ½ per cent) saccharin to impart a sweet taste. The oil is then flavored by adding small quantities of oil of cinnamon and extract of vanilla or other flavoring substances.

The following formula has been recommended:

Pure castor oil	1 pint
Cologne spirit	3 fl. ounces
Oil of wintergreen	40 minims
Oil of sassafras	20 minims
Oil of anise	15 minims
Saccharin	5 grains
Hot water	a sufficient quantity

Place the castor oil in a gallon bottle. Add a pint of hot water and shake vigorously for about fifteen minutes. Then pour the mixture into a vessel with a stopcock at its base, and allow the mixture to stand for twelve hours. Draw off the oil, excepting the last portion, which must be rejected. Dissolve the essential oils and saccharin in the cologne spirit and add to the washed castor oil.

Another formula is the following: First prepare an aromatic of saccharin as follows:

Refined saccharin	25 parts
Vanillin	5 parts
Absolute alcohol	950 parts
Oil of cinnamon	20 parts

Dissolve the saccharin and vanillin in the alcohol, then add the cinnamon oil, agitate well and filter. Of this liquid add 20 parts to 980 parts of castor oil and mix by agitation. Castor oil, like cod liver oil, may be rendered nearly tasteless, it is claimed, by treating it as follows: Into a matrass of suitable size put 50 parts of freshly roasted coffee, ground as fine as possible, and 25 parts of purified and freshly prepared bone or ivory black. Pour over the mass 1,000 parts of the oil to be deodorized and rendered tasteless, and mix. Cork the container tightly, put into a water bath, and raise the temperature to about 140 degrees F. Keep at this heat from 15 to 20 minutes, then let cool down, slowly, to 90 degrees, at which temperature let stand for three hours. Finally filter, and put up in small, well stoppered bottles.—Pharm. Era.

Cologne Water.—In a paper presented at the last meeting of the American Pharmaceutical Association Prof. Scoville gave a formula for cologne water. The Bulletin of Pharmacy notes receipt from the author of a letter stating that the formula as published contained an inaccuracy, and that it should be as follows:

Oil of bergamot	1½ ounces
Oil of lemon	6 drachms
Oil of neroli	½ ounce
Oil of orange	2 drachms
Oil of rosemary	2 drachms
Tincture of benzoin	1 ounce
Orange-flower water	12 ounces
Alcohol, enough to make	1 gallon

Lacquer for Brass.—

Annatto	¼ ounce
Saffron	¼ ounce
Turmeric	1 ounce
Seed lac in coarse powder	3 ounces
Alcohol	1 pint

Digest the annatto, saffron, and turmeric in the alcohol for several days, then strain into a bottle containing the seed lac; cork and shake until dissolved.—Drug. Circ.

Raspberry Vinegar.—

Fresh raspberries	3 pounds
White wine vinegar	3 pints

Place together in a glass vessel, stir frequently for three days, then press and strain.

In each pint of the strained liquor dissolve 1 pound of sugar.—Drug. Circ.

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